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Forest insect and disease conditions

British Columbia & Yukon 1987

C.S. Wood, G.A. Van Sickle and L.M. Humble

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Abstract

This summary of forest pest conditions in British Columbia and the Yukon Territory in 1987 highlights pests that are or may become major forest management problems. It was compiled from records and field reports of 11 Forest Insect and Disease Survey rangers with contributions from forest agencies, researchers, and industry. More than 40 forest pests are discussed and some predictions are made for 1988.

Résumé

Le présent résumé sur les ravageurs des forêts de la Colombie-Britannique et du Yukon, en 1987, porte sur ceux qui posent ou peuvent poser de graves problèmes aux aménagistes. Il synthétise les observations et les rapports de 11 techniciens du RIMA, en intégrant les contributions des chercheurs, des organismes et de l'industrie forestière. Plus de 40 ravageurs font l'objet de discussion et de prévisions pour 1988.

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Introduction

The Forest Insect and Disease Survey (FIDS) of the Canadian Forestry Service (CFS) is responsible for producing an annual national overview of important forest pest conditions and their implications. In the Pacific Region, general surveys are conducted to detect and monitor important forest insects, diseases, and environmental factors. Additionally, surveys and records are maintained in support of quarantine programs, forest research projects, and herbaria and insect collections. Surveys are conducted with the cooperation of the British Columbia Forest Service, other federal and provincial agencies, municipalities, the forest industry, educational centers, and research programs at the Pacific Forestry Centre and other CFS centers nation-wide.

This regional report reviews the status and impact of major forest insects and diseases and the effects of environmental factors on conifer and broadleaf forests in British Columbia and the Yukon Territory in 1987, and forecasts trends of some pests and their potential damage in 1988. Damage trends and expansion of infestations can be determined by comparison to previous years' reports.

Throughout this report, the subjective terms "light," "moderate," and "severe" are used to describe the level of total defoliation. Unless otherwise stated, these are defined as: 1 to 25%, 26 to 65%, and more than 66% defoliated, respectively.

The report is compiled from information obtained largely from field observations and records of 11 FIDS rangers collected during their field assignments from late May to October in six provincial forest regions and the Yukon Territory. More detailed information on the status of forests pests is available in reports compiled by the following FIDS rangers:

Cariboo — Dick Andrews
Kamloops — Bob Erickson and Jim Loranger
Nelson — Peter Soot and John Vallentgoed
Prince George — Rod Garbutt and Rod Turnquist
Prince Rupert — Leo Unger and Alan Stewart
Vancouver — Nick Humphreys and Rob Ferris
Yukon Territory — Rod Turnquist

Other staff of the Forest Insect and Disease Survey project in 1987 were:

Allan Van Sickle — Head, Forest Insect and Disease Survey
Colin Wood — Chief Ranger
Joan Strobbe — Secretary
Lee Humble — Entomologist — insectary and collection
Bob Duncan — Insectary Technician — diagnostics
Erika Pass — Insectary Technician — rearing and data base
Al Funk — Pathologist — disease identification
Daphyne Lowe — Herbarium Technician

Summary

The record mild 1986-87 winter, above-average summer temperatures, a record number of days of sunshine, and below-average rainfall throughout most of British Columbia in 1987 were conducive to high survival of overwintering insect populations and successful development of major forest pests.

Mountain pine beetle was the most damaging forest insect in British Columbia and killed mature pine in 8866 infestations over more than 66 470 ha in six forest regions from the international border to northeast of Prince Rupert. Infestations expanded in the Prince Rupert and Prince George regions and in the Cariboo Region for the first time in 2 years, but declined overall elsewhere. Mature pine killed before 1985 over 1.8 million ha in the Cariboo Region and 75 000 ha in the Kamloops Region are legacies of more than 10 consecutive years of infestation. High numbers of mainly predisposed mature pine were killed by increased **pine engraver beetle** populations in five forest regions. **Pine needle sheathminer** again severely defoliated new lodgepole pine shoots in widely scattered stands in three forest regions. **Pine stem, branch, and needle diseases** were common and widespread in young and some older interior pine stands. **Pinewood nematode**, a factor limiting exports of wood chips but not currently a pest causing conspicuous damage to forests in British Columbia, was extracted from only 12 conifers and from one adult woodborer. Increased numbers of **conifer weevils** defoliated new shoots of immature lodgepole pine in the Cariboo Region.

More than 834 000 ha of interior Douglas-fir forests, mostly in the Kamloops Region, were defoliated by **western spruce budworm** in 1987. This was more than double the area affected in 1986 and was the most expansive outbreak in more than 50 years. The major expansion was in the North Thompson and Adams river drainages and the north Okanagan Valley of the Kamloops Region, in the eastern Cariboo Region and near Pemberton in the Vancouver Region. Feeding in small areas of Douglas-fir previously defoliated in the southwestern part of the Nelson Region, and in large areas east and north of Ashcroft in the Kamloops Region, decreased. Larval parasitism was low (average 18%) and egg mass numbers forecast mostly severe defoliation in 1988.

About four times as many male adult **Douglas-fir tussock moths** were collected in twice as many pheromone-baited sticky traps as in 1986. No larvae or egg masses were found. Some defoliation may occur west of Kamloops and in the north Okanagan Valley in 1988; an outbreak may start in 1989. The number of mainly overmature predisposed Douglas-fir killed by **Douglas-fir beetle** remained at endemic levels throughout the host range.

The overall decline in area and volume of mature white and Engelmann spruce killed by **spruce beetle** in British Columbia continued for the fifth consecutive year. Of 63 separate infestations totalling 3300 ha, most were in the Kamloops and Prince George regions. Mature spruce were very lightly strip-attacked along the Haines Road north of the Alaska border in the Prince Rupert Region where attacks have fluctuated periodically since 1983. The general population decline is expected to continue in 1988.

Mature 1-year cycle **eastern spruce budworm** defoliated alpine fir and spruce over 59 400 ha north and west of Fort Nelson and into the Yukon Territory, down from 95 000 ha in 1986. Immature **2-year cycle budworm** larvae defoliated new shoots of alpine fir and spruce over 48 250 ha in 180 infestations in the Prince George, Kamloops, and Cariboo regions. Increased populations were forecast in 1986 based on egg samples, but the defoliation was not expected to be as widespread until 1988 when the larvae mature. Mature **"off-year" 2-year cycle budworms** lightly defoliated alpine fir and spruce over 11 500 ha in the Nelson Region, mainly in the East Kootenay and in the Arrow Lakes drainage in the West Kootenay. Egg samples indicate continuing moderate to high numbers of larvae in 1988.

In the third consecutive year of outbreak, **western blackheaded budworm and hemlock sawfly** larvae defoliated mature and immature western

hemlock over 14 100 ha on the Queen Charlotte Islands, down two-thirds from 1986. Populations near Kitimat collapsed with no defoliation. Fluctuating populations in the eastern part of the Prince Rupert Region lightly defoliated new shoots of white spruce and alpine fir from Nadina River to near Hazelton. Populations increased in hemlock stands in Wells Gray Provincial Park in the Kamloops Region in five pockets totalling 1100 ha and on 5 ha near Holberg on Vancouver Island. Based on budworm egg counts, reduced populations and decreased defoliation of hemlock on the Queen Charlotte Islands is forecast in 1988. Parasitism of budworm larvae averaged 6% at Honna Valley. Defoliation is not expected near Kitimat, but there could be light defoliation in hemlock stands near Holberg and on spruce and alpine fir in the eastern part of the Prince Rupert Region. Sawfly prepupal mortality averaged 54% but defoliation is still forecast at 10 of 27 locations, mostly on Graham Island. Growth impact studies will resume following the collapse of the outbreak. A new infestation of **western hemlock looper** severely defoliated western hemlock at Jervis Inlet in the Vancouver Region, the first population increase since 1962.

After 2 successive years of decline, **larch casebearer** populations were generally endemic in western larch in southeastern British Columbia. Isolated pockets of moderate or lightly defoliated mature larch occurred between Montrose and Anarchist Mountain, in the West Kootenay, and between Koocanusa Lake and Creston in the East Kootenay. More than 330 European parasites were released near Castlegar in the continuing biological control program initiated in 1966. Casebearer populations extended slightly beyond known distribution limits, based on limited trapping of male moths in sticky traps. Increased numbers of **larch sawfly** in the northern part of the Prince Rupert Region moderately defoliated numerous small groups of tamarack north of Dease Lake and in the Yukon. Colonies severely defoliated a single non-native larch in Terrace, the first record of the defoliator south of Dease Lake. Discoloration of western larch by needle diseases was conspicuous for the second consecutive year in the western part of the Nelson and Kamloops regions and to a lesser extent in the southeast. Very low numbers of **larch budmoth** larvae, but no visible feeding damage, were evident in widely separated western larch stands between Castlegar and Anarchist Mountain, but not elsewhere in stands defoliated by budmoth from 1983 to 1985.

New infestations of **black army cutworm** severely defoliated conifer seedlings and herbaceous ground cover and delayed planting programs in 2-year- old burns in the East Kootenay and in the Kamloops Region. Significant population declines occurred in previously infested areas in the Prince Rupert, Prince George and Cariboo regions. **Rhizina** root disease was common but not yet damaging in several burned cutblocks in the Prince Rupert Region. A **variegated cutworm** found in high numbers in a newly planted site in the Cariboo Region in 1986 failed to survive the winter.

Cone and seed pests were at the highest levels in recent years. A **Douglas-fir coneworm** destroyed up to 85% of the cones at 34 sites in four forest regions and very lightly defoliated new shoots of Douglas-fir in two natural stands near Williams Lake. A previously undescribed **gall midge** infested yellow cedar buds and cones in three seed orchards on Vancouver Island. High numbers of **western spruce budworm** larvae in an interior seed orchard were reduced by applications of Sevin and *Bacillus thuringiensis*.

Pests of deciduous forest trees were common for the second consecutive year. Defoliation of trees and shrubs by **forest tent caterpillar** was more severe and widespread in parts of the Cariboo, Kamloops, Nelson, and Prince George regions than in 1986 but declined in the Peace River area. **Western tent caterpillar** colonies in southwestern British Columbia declined due to increased virus infection, but again increased in the Okanagan Valley. Effective monitoring with pheromone-baited sticky traps, egg searches, and periodic control programs have prevented establishment of **gypsy moth** in British Columbia since it was first detected in Vancouver in 1974. However, in the cooperative surveys, about 221 male moths were trapped in 74 traps in six areas, up from 24 in 19 traps. Fluctuating **satin moth** populations in the Kamloops Region severely defoliated a cottonwood stand at Stump Lake south of Kamloops but declined elsewhere in the region. Mixed deciduous stands in the North Thompson River Valley were defoliated by **western winter moth** for a second year, while stands in adjacent parts of the Cariboo Region were defoliated for the first time in 10 years; popula-

tions increased in the Vancouver Region. **Winter moth** populations in Garry oak and maple on southern Vancouver Island were at very low levels for the third consecutive year, due in part to increased parasitism by introduced parasites. **Poplar leaf and shoot blight** of aspen was more widespread in the Cariboo, Nelson, and Prince George regions. Discoloration of scattered patches of white birch by a **birch leaf skeletonizer** was widespread in the northern part of the East Kootenay in some areas for the thirteenth consecutive year. Increased mortality of willow by **poplar and willow borer** was widespread in the Cariboo Region and around Prince George, where until recently it has not been very common.

As well, 56 insects and diseases on 44 hosts were documented in British Columbia and the Yukon Territory either for the first time, or on new hosts, or beyond previously known distribution limits.

Pine Pests

Mountain pine beetle
Dendroctonus ponderosae

The area and volume of lodgepole pine and some white pine killed by mountain pine beetle declined overall by about 30% to the lowest level in 7 years (Figure 1). However, more than 8900 infestations are still active on more than 66 470 ha (Table 1) from the international border south of Cranbrook to north of Terrace (Map 1). This is almost double the area burned by forest fires in British Columbia in 1985 and represents about 10% of the annual lodgepole pine harvested. Also, lodgepole pine killed by the beetle before 1985 and which is now unsalvageable covers more than 1.86 million ha and 75 000 ha in the Cariboo and Kamloops regions, respectively, and 575 ha in the Prince George Region.

Declines due to host depletion occurred in the western part of Kamloops Region (down 60% to 19 000 ha) and in the Homathko River Valley in the Vancouver Region (down 65% to 1470 ha). Infestations declined 18% in the Nelson Region, but remained active over 23 100 ha mainly south of Cranbrook, near Invermere, and in the Boundary District. The area of pine killed by the beetle increased in three regions. In the Cariboo Region, where in late 1984 and early 1985 most populations were killed by below-normal temperatures, a new infestation developed over 500 ha near Chilko Lake. In the Prince Rupert Region, the increase was 25% to 18 600 ha, and in the Prince George Region there was an increase of nearly threefold to 4300 ha, mostly northwest of Fort St. James.

Overwintering brood mortality assessed in 52 major infestations in six forest regions in early 1987 was less than 10%. Regional *R* values, the ratio of overwintering progeny to parent beetles, ranged from 0 to 20; most were greater than 4.1, the threshold indicating static to increasing populations. In the Kamloops Region, *R* averaged 7.8; the lowest values occurred west of Lillooet.

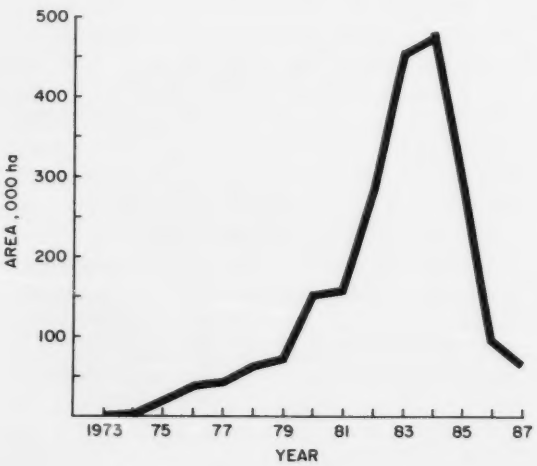


Figure 1. Total area with mountain pine beetle-killed trees by year in British Columbia.

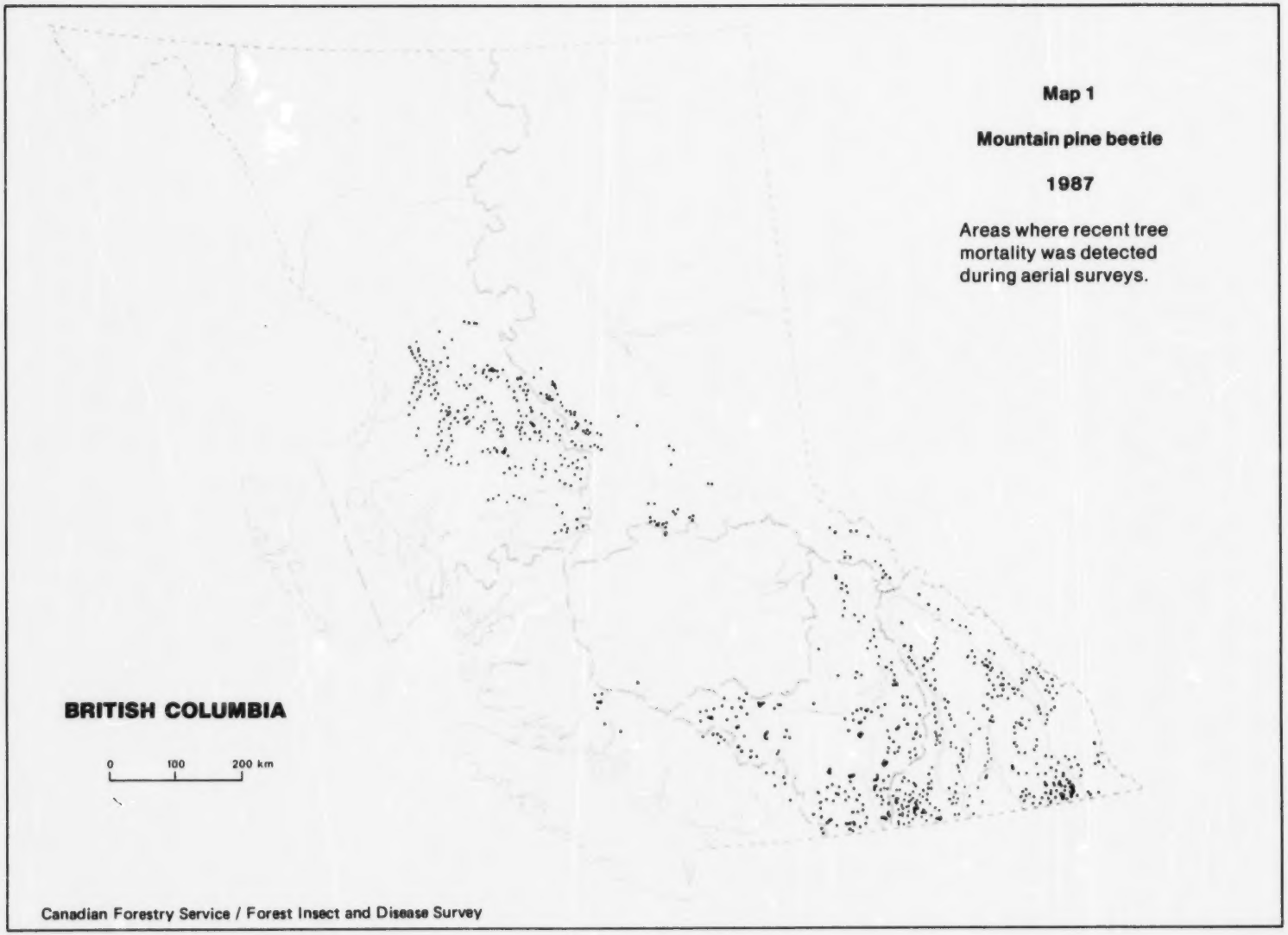

Map 1
Mountain pine beetle
1987
Areas where recent tree mortality was detected during aerial surveys.
BRITISH COLUMBIA
0
100
200 km
Canadian Forestry Service / Forest Insect and Disease Survey

Table 1. Number, area and incidence of new and old attack of mountain pine and engraver beetle by forest region, based on recently killed trees recorded by aerial and ground surveys in British Columbia in 1987

Forest Region	Infestations	Area (ha)	Trees killed[a]		Stands cruised[b]		Damage category[c]				
			No. (000)	Vol. (000 m³)	No.	Avg. yrs. infested	H	C	R	G	P
							--------% of trees --------				
Cariboo[d]	7 250	3900	–	–	8	–	58	–	38	4	–[e]
Kamloops	1 515	19 000	1 849	852	11	4	72	6	8	11	3
Nelson	4 367	23 100	1 222	444	13	5	68	13	5	10	4
Prince George	810	4 300	160	132	2	5	43	34	14	3	6
Prince Rupert	2 073	18 600[f]	2 521	1 495	12	7	49	33	12	4	2
Vancouver	101	1 470	55	39	4	6	43	12	19	17	9
Total	8 866	66 470	5 807	2 962	42		55	20	12	9	4

[a] Trees attacked in 1986, discolored in 1987
[b] Some stands located in younger infestations may not represent average condition.
[c] H = Healthy; C = Current, attached in 1987; R = Red, attacked in 1986; G = Grey, attacked in or before 1985; P = Partial, or strip attack.
[d] Estimates include data from the British Columbia Forest Service and includes mostly pine killed by pine engraver beetle which are not included in the total.
[e] Pine engraver beetle only; mountain pine beetle was not found in stands cruised.
[f] Estimates include data from the British Columbia Forest Service.

In the Nelson Region, the average *R* value was 9.4. In the eastern part of the Prince Rupert Region *R* values averaged 7.9, and they averaged 4.1 in western areas. The highest average *R* values (16.0) were northwest of Fort St. James, near Elliot and Trembleur lakes. Populations near Pemberton in the Vancouver Region remain static or are in decline (average *R* was 2.9) due to declining availability of suitable host material.

A mild 1986-87 winter and a hot, dry 1987 summer, along with increased populations resulted in an increased number of new attacks in mature lodgepole pine. New attacks averaged 20% in 42 stands in five forest regions, up from 11% in 1986. Current attacks were higher in all regions; the highest were in the Prince George and Prince Rupert regions at 34% and 33%, respectively. Other increases occurred in the Kamloops Region (average 6%, range 0 to 27%) particularly east of Kelowna, the Nelson Region (average 13%, range 0 to 64%) in which the highest increase was Kootenay National Park, and near Pemberton in the Vancouver Region (12%). Most stands surveyed were in or adjacent to infestations that have been active for at least 3 years, and some that have been active for up to 14 years.

The area of mature pine killed by the beetle in 1987 in the Kamloops Region contained about 1.8 million trees (852 000 m³) over the smallest area affected since 1979. Additionally, pine over more than 75 000 ha killed by earlier attacks remain. The decline, largely due to host depletion, occurred mainly in the Lillooet Timber Supply Area (TSA) where most mature suscepti-

ble lodgepole pine has been killed since 1972 when the outbreak first developed. However, active infestations continue in the Okanagan TSA east of Kelowna, in Mission, Belgo, and Daves creeks and west of the Okanagan Valley in Trout, Hayes, and Short creeks. Groups of 5 to 10 beetle-killed pine in the Merritt TSA are less numerous this year and are often associated with an intensive pheromone-baiting program by the British Columbia Forest Service. Pockets of recently killed pine were widely distributed southwest of Princeton and spot infestations southwest of Keremeos follow host depletion and some harvesting.

Pine mortality in the Cariboo Region remained at the lowest levels since 1972; however, a new infestation over about 500 ha was recorded by the British Columbia Forest Service near Franklyn Arm on remote Chilko Lake near the Coast Mountain Range. Pine mortality is expected to remain generally at low levels throughout the region in 1988. Cruises in eight stands adjacent to beetle-killed mature pine southwest of Riske Creek found 38% of the stems attacked by engraver beetles, *Ips pini*, but no new mountain pine beetle attacks were found. An additional 7250 pockets containing a total of 3400 ha of pine which were recently killed by *Ips pini* were mapped by the British Columbia Forest Service in the western part of the region.

Mountain pine beetle infestations in the Nelson Region (including those in national parks) declined 18% to 23 100 ha containing 1.2 million trees (440 000 m^3). Although infestations along the British Columbia-Alberta border continued to decline, those in the Boundary, Cranbrook, and Invermere TSAs and in Kootenay National Park increased for the second consecutive year to 4367 infestations. New attacks in the region increased slightly to an average of 13% in 13 stands indicating continued but varied amounts of tree mortality in 1988 with the highest at Redstreak Creek (64%) in Kootenay National Park, and near Steamboat Mountain (25%) west of Invermere. New attacks in the Boundary District ranged from 2 to 17% (average 9%); the highest level of new attacks occurred near Eholt.

The area of lodgepole pine killed by the beetle in the Prince Rupert Region increased, for the second consecutive year, to 18 600 ha which contained 2.5 million trees (1.5 million m^3). This major increase occurred throughout previously infested areas, mainly the Kispiox, Hazelton, and Kitwanga areas, resulting in part from increased populations and in part from varied aerial mapping standards. Increased tree mortality is again forecast; current attack is forecast to increase 33% overall (range 11 to 68%).

Infestations expanded nearly threefold in the Prince George Region to 4300 ha (160 000 trees; 132 000 m^3), mostly northwest of Fort St. James. More than 220 infestations occurred from the Tarnezell Lake area to south of Takla Landing. Pine beetle control operations in Mt. Robson Provincial Park reduced the number of beetle-killed pine to 21 trees from 259 in 1985 and 26 in 1986. Host depletion and harvesting in the Canoe Arm area south of Valemount further reduced the number of beetle-killed white and lodgepole pine to 520 trees over 220 ha. Current attack in two representative stands northwest of Fort St. James averaged 34%, indicate continuing populations in 1988. Southwest of Prince George, declining mountain pine beetle populations were found in one stand and only high numbers of engraver beetles were found in two others. An estimated 570 ha in the Sustut River drainage contained mature pine killed by the beetle in 1985 and earlier.

The total area containing recently killed pine in the Vancouver Region declined to 1470 ha and 55 000 trees (39 000 m^3), and the number of infestations declined 43%. The decline, due to host depletion, was mostly in the Homathko River Valley, and a lesser decline occurred east of Pemberton.

Secondary beetles, mainly engraver beetles, *Ips pini*, and to a lesser degree *Dendroctonus murrayanae* and *Trypodendron* spp., attacked and killed predisposed mature pine adjacent to recently harvested stands particularly in parts of the Cariboo, Nelson, Prince George, and Prince Rupert regions. Pine engraver beetle killed about 38% (range 0 to 46%) of the mature lodgepole pine in eight stands in the Cariboo Region west of the Fraser River in the Big, Churn, and Gaspard creek drainages. Tree mortality resulting from attacks in May and July was evident within 15 m of cutblock boundaries. Slash accumulation and hot dry weather which prevented slash disposal were the major factors in increased beetle populations.

Pinewood nematode
Bursaphelenchus xylophilus

Two forms of pinewood nematode were found in 1987 in small numbers in four species of previously damaged or predisposed conifers at 12 locations in five regions and in one adult woodborer. Based on about 500 trees and 500 potential vectors sampled since 1983, the nematode is not a conspicuous or damaging forest problem in British Columbia and the Yukon.

Based on preliminary identifications, the *m* form of *Bursaphelenchus xylophilus* was extracted from recently killed lodgepole pine near Creston, Marysville, Vanderhoof, and Prince George, from western white pine near D'Arcy in the Vancouver Region, from Scots pine near Smithers, for the second consecutive year from a dead lodgepole pine near Houston, and from an adult *Monochamus maculosus* from Wasa Lake in the Nelson Region. The *r* form was recovered from lodgepole pine near Boston Bar, Tranquille, and Cassiar and in a Douglas-fir near Skookumchuck in the Nelson Region. Both forms were in a lodgepole pine near Brisco in the East Kootenay. Of the 158 trees sampled in 1987, 61 had nematodes but only the 11 noted above contained *B. xylophilus*.

Collections of 439 adult woodborers, mostly from log decks, were extracted for nematodes. These collections included 17 species of cerambycids, eight species of buprestids, and five species of siricids. The most common woodborer examined was *Monochamus scutellatus* (246), of which 12% contained various nematodes. Other woodborers with nematodes associated included *M. maculosus* (18%), *Buprestis rusticorum* (16%) and *B. nuttallii* (23%). Less frequently collected were *M. notatus*, *Xylotrechus undulatus*, and *Dicera tenebrosa*. In most cases the nematodes extracted from adult woodborers were free-living bacterial feeders in the Tylenchidae or Rhabdidae and occasionally Aphelenchidae. Only two *M. maculosus* contained *Bursaphelenchus*; one from near Wasa Lake in the Nelson Region had *B. xylophilus m* form and a sample near Kamloops had a *Bursaphelenchus* sp. for which identification is pending.

Baited barrier and sticky traps placed adjacent to wood chip piles at pulp mills at Crofton and Prince George and near sawmills at Williams Lake and the Upper Fraser Valley attracted mainly leaf beetles, *Altica tombacina*, and weevils of herbaceous vegetation and only one woodborer. Lindgren traps at sawmills near Smithers attracted small numbers of adult buprestid woodborers.

Pine needle sheathminer
Zelleria haimbachi

High numbers of the sheathminer infested and severely defoliated new shoots of lodgepole pine over more than 650 ha in 15 separate infestations in the Kamloops, Nelson, and Vancouver regions, some of which were attacked for the third consecutive year.

Most new shoots of mainly immature pine were severely defoliated over about 300 ha near Salmon Arm for the third consecutive year. Pine stands from Birch Island to McMurphy in the North Thompson River Valley were moderately defoliated for a second year. Stands in this area were severely defoliated by the sheathminer in 1979 and 1980. Individual immature lodgepole pine near Gold Bridge were lightly discolored, as were up to half the shoots of mixed-age pine along Chase Creek.

New shoots of regeneration lodgepole pine between Cranbrook and Yahk were very lightly defoliated, in contrast to the severe defoliation during 1986, the first year of defoliation. West of Grand Forks, semimature lodgepole pine in five patches totalling 225 ha were severely defoliated for the first time in recent years. Additionally, roadside trees between Grand Forks and Greenwood, and for 20 km along the Kettle River Valley road and along State Creek, were lightly defoliated. Near Kaslo, pine over 3 ha were very lightly defoliated for the second consecutive year.

Defoliation of pine regeneration in the Vancouver Region was light to moderate in six areas over 150 ha, including stands on the east side of Lillooet Lake defoliated for a second consecutive year. New areas of defoliation occurred near Pemberton and Keefers, and on the west side of Harrison Lake where about a third of all new pine shoots were defoliated in two areas of 20 and 55 ha.

Limited assessments of parasites and overwinter-

ing populations were insufficient to allow an accurate prediction for 1988.

A needle miner, *Coleotechnites* sp., commonly associated with *Z. haimbachii*, defoliated up to 70% of the new foliage on the tops of groups of 10 to 20 lodgepole pine near Ootsa Lake in the Prince Rupert Region.

Pine needle diseases

Lophodermella concolor
Dothistroma pini
Elytroderma deformans

Native needle diseases were common in lodgepole pine stands in parts of the Nelson, Prince George, and Kamloops regions following 2 successive years of decline, and in the southern part of the Yukon Territory. Systemic infections in ponderosa pine were high throughout most of the host range, particularly in the Kamloops Region, similar to the last 4 years.

Infection by *Lophodermella concolor* increased generally in the East Kootenay part of the Nelson Region. An average of 30% of the 1-year-old needles on all the regeneration lodgepole pine over 5 ha in Redding Creek near Kimberley were infected and up to 50% of the needles in adjacent overstory pine were lost prematurely due to the previous year's infections. Severely infected lodgepole pine were also common in Matthew Creek, and lightly infected stands were common elsewhere throughout the Cranbrook District. North of Watson Lake, Yukon Territory, 25% of the older foliage on lodgepole pine in a natural stand were moderately infected, but less than 5% of the pine were infected in a forest reserve at Takhini near Whitehorse.

Infection of 1-year-old white pine needles in a long-term damage assessment plot at Summit Lake near New Denver in the Nelson Region averaged 80% in the lower third of the crown and 10% of the mid crown, up from generally light infection in 1986. Consecutive years of infection have resulted in premature loss of about 70% of the needles on all plot trees.

A third of the 1-year-old needles on most regeneration lodgepole pine in pockets up to 50 ha near Roche and Paska lakes west of Little Fort in the Kamloops Region were infected by *D. pini*; this was more severe than in 1986.

Needle discoloration and brooms caused by *E. deformans* infection were common in most interior ponderosa pine stands, particularly in the Kamloops Region. Up to 75% of the crowns of the mature pine were infected in many stands up to 100 ha.

A conifer weevil

Magdalis sp.

Moderate to severe defoliation of lodgepole pine by this weevil was recorded for the first time in British Columbia in the Cariboo Region. New shoots in two recently spaced young stands near Moffat Lake south of Horsefly, in immature pine near Mt. Alex west of Dog Creek, and south of Williams Lake near Spring Brook were defoliated by adult weevils. Weevil populations, which usually infest slash, increased in part due to high overwintering survival during the mild 1986-87 winter, the hot dry summer, and the increased availability of slash arising from thinning and harvesting of mature pine killed by mountain pine beetle.

Douglas-fir Pests

Western spruce budworm
Choristoneura occidentalis

The area of mature and immature interior Douglas-fir defoliated by the budworm in 1987 doubled to more than 834 000 ha in more than 1060 separate infestations, mostly in the Kamloops Forest Region but including small areas in three adjacent regions (Map 2). This is the largest area of Douglas-fir defoliated by this budworm in British Columbia since surveys started 50 years ago. Most of the defoliated Douglas-fir stands were in the Kamloops Region (98%); less extensive defoliation occurred in the Cariboo, Nelson, and Vancouver regions. Overall, 76% of the defoliated areas sustained light defoliation, 22% sustained moderate defoliation, and 2% sustained severe defoliation. The most significant areas of expansion were in the Kamloops Region at the northern limits of the host range near Clearwater and Wells Gray Provincial Park in the North Thompson River Valley and east of Clearwater in the Adams Lake drainage. Smaller expansions occurred around Vernon and west of Penticton in the Okanagan Valley. Areas of Douglas-fir defoliated in 1986 but not this year totalled more than 76 000 ha; most of the areas of decline (59 000 ha) occurred in the Savona, Ashcroft, and Clinton areas. Contributing factors included population starvation, migration, and parasitism.

The area of Douglas-fir defoliated by the budworm in the eastern part of the Cariboo Region increased significantly to 9000 ha in 37 separate areas of mainly light defoliation near Quesnel, Horsefly, Canim, and Mahood lakes. Major expansion occurred near Mahood Falls and Bowers Lake where defoliation occurred for the first time in 1986 over 180 ha. In the southern part of the region, Douglas-fir over 550 ha on Big Bar Mountain west of Clinton were moderately defoliated again after a population decline in 1986.

Budworm populations again increased near D'Arcy in the Vancouver Region and lightly to moderately defoliated Douglas-fir over 2850 ha in 13 areas in the Blackwater, Haylmore, and Gates creek drainages, up from 1250 ha in 1986.

Douglas-fir east of Anarchist Mountain in the Nelson Region were lightly defoliated over 1000 ha, down from 3700 ha in 1986. Undetermined natural factors affected overwintering early-instar larvae.

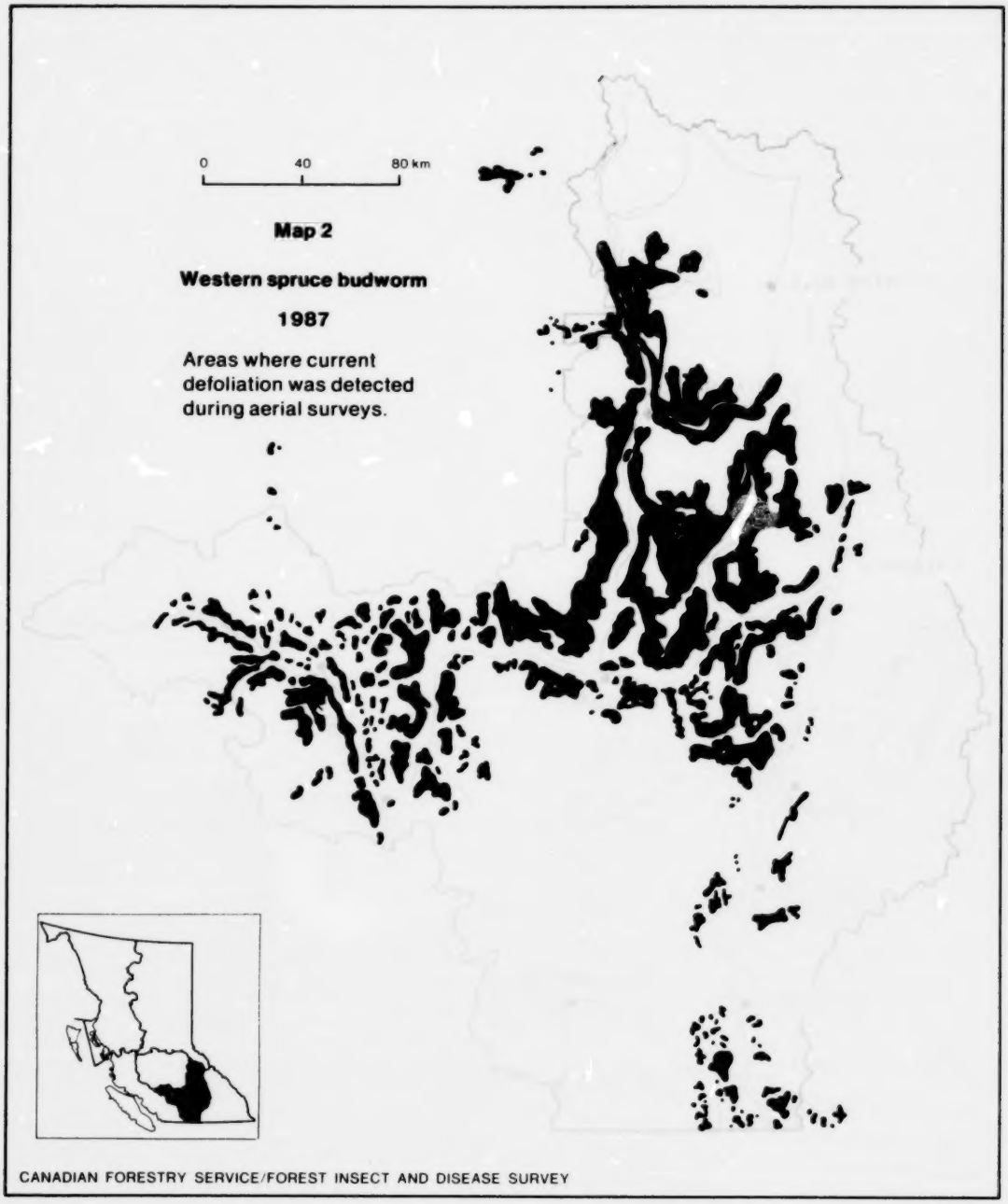
The last 6 years of budworm infestations were compared by computer overlays to aid tree condition assessments. Of the total area infested to date, most (60%) has been defoliated 1 year, 27% has been defoliated for 2 consecutive years, 10% for 3 consecutive years, and 2% for 4 years. Less than 1% of the total area had been defoliated for 5 or 6 years.

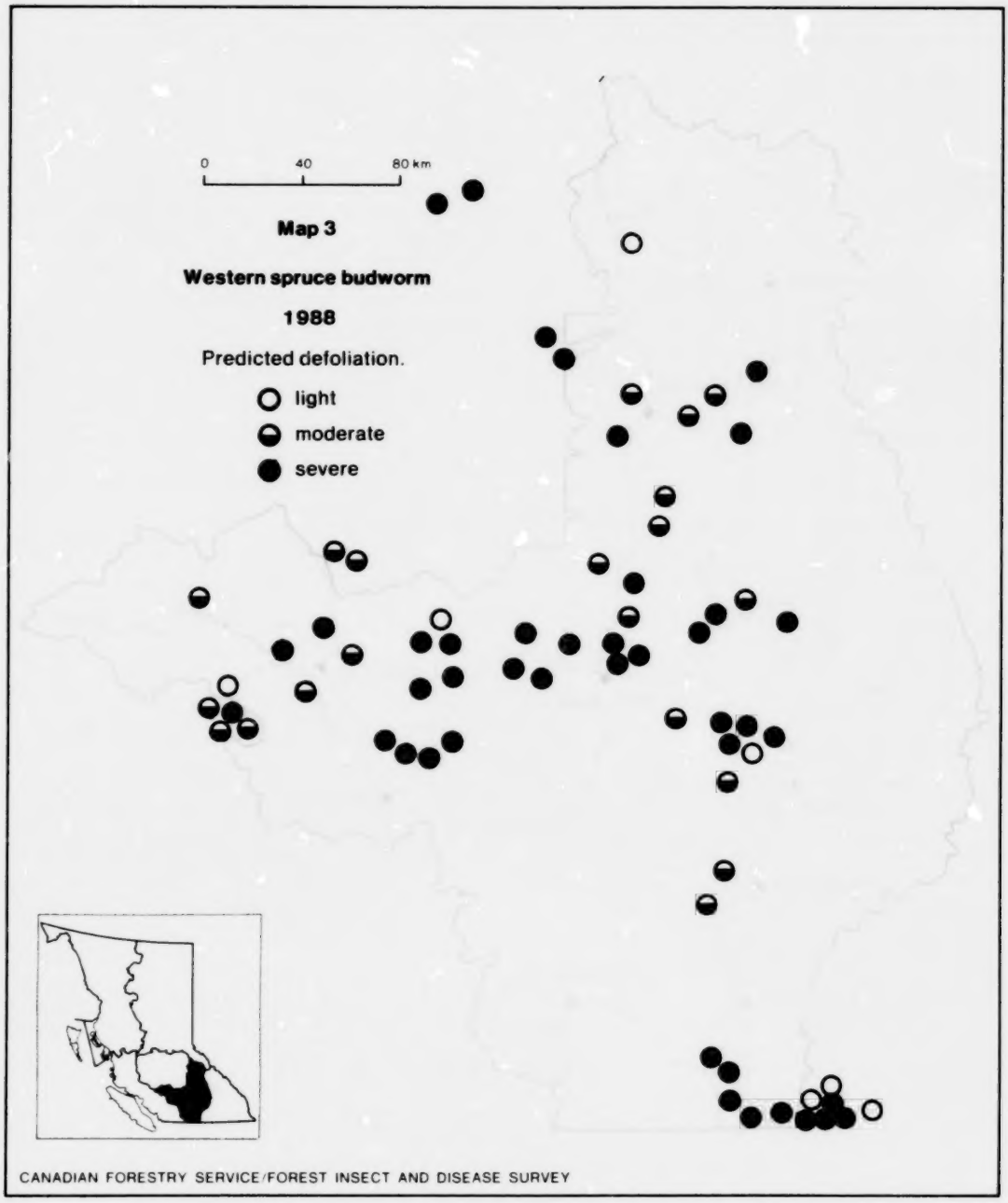
Based on egg masses per 10 m^2 of foliage from 10 trees at each of 67 locations, defoliation in 1988 is forecast to be severe in 61% of stands in the Kamloops and adjacent regions, moderate in 27%, and light in the remainder (Map 3). Most of the severe defoliation will be in the Kamloops Region in the North Thompson, Adams River, and Okanagan Valley drainages, with smaller areas in the eastern part of the Cariboo Region and east of Anarchist Mountain in the Nelson Region. Light to severe defoliation is forecast for the D'Arcy area in the Vancouver Region. In stands defoliated in both 1986 and 1987, defoliation is again predicted, but there was a 31% decrease in the number of egg masses. Also, the forecasts may be slightly conservative.

Comparisons of predicted and actual defoliation, based on 1986 egg samples and 1987 defoliation at 36 locations in the Kamloops Region, showed agreement at 48% of the sites, less defoliation than predicted at 40% of the sites, and more severe defoliation than predicted in only 12% of the stands.

Parasitism of early- and late-instar larvae occurred at all 28 sites sampled, mostly in the Kamloops Region, and averaged 18% (range 6 to 79%), up 10% from 1986, but too low to effectively reduce populations. There was no evidence of viral or fungal infections.

Larvae and male adult populations were monitored at 14 locations in four regions to improve


0
40
80 km
Map 2
Western spruce budworm
1987
Areas where current defoliation was detected during aerial surveys.
CANADIAN FORESTRY SERVICE/FOREST INSECT AND DISEASE SURVEY


0
40
80 km
Map 3
Western spruce budworm
1988
Predicted defoliation.
light
moderate
severe
CANADIAN FORESTRY SERVICE/FOREST INSECT AND DISEASE SURVEY

and calibrate methods to detect western spruce budworm in Douglas-fir forests. Further data are necessary before numbers can be correlated with population changes and damage.

Mortality of understory trees, top-kill, and growth loss are variable but evident in stands moderately or severely defoliated for more than 4 successive years, mostly in the Kamloops Region. Near Ashcroft, mortality of immature and some mature Douglas-fir, a result of about 6 consecutive years of severe defoliation, was mapped over 540 ha. In 65 plots of open-growing regeneration, mortality averaged 3% (range 0 to 33%) and much of the remainder are severely defoliated. Greater damage exists where regeneration is over-topped by older trees.

An aerial spray trial, conducted by the British Columbia Forest Service and the British Columbia Ministry of Environment and Parks, applied *Bacillus thuringiensis* over about 200 ha of budworm-infested Douglas-fir at Paul Lake Provincial Park near Kamloops and over 10 nearby blocks of immmature Douglas-fir totalling 700 ha.

Douglas-fir tussock moth
Orgyia pseudotsugata

Increased numbers of male adults caught in pheromone-baited sticky traps for the second consecutive year reflect a possible outbreak in Douglas-fir stands in 1988-89 in parts of the Kamloops and Nelson regions previously infested by the tussock moth. Larvae were not found at any permanent monitoring sites or in other susceptible stands. A total of 387 adult males were trapped in 45 of 120 traps at 12 of 20 sites in two regions, up from 75 moths in 25 traps in 1986.

Populations are forecast to increase again in 1988 based on the increased numbers of male adults. Larval detection and adult trap monitoring programs will be intensified, particularly near Cherry Creek and Winfield where the average number of moths per trap increased to 24 and 23, respectively. Average catches of 8 to 10 moths per trap indicate a potential outbreak in 2 years. The last outbreak, which lasted 3 years and collapsed in 1984, covered 23 500 ha, mainly in the Kamloops Region.

Growth loss in Douglas-fir stands defoliated in 1981 and sprayed with *Bacillus thuringiensis* in 1982 is still being evaluated by the Damage Appraisal group of the CFS. Cumulative mortality of Douglas-fir defoliated from 1981 to 1983 by tussock moth in the Kamloops Region averaged 51% of the trees (49% by volume) and 11% of the survivors were top-killed. Assessments in 45 plots showed that 56% of the dead trees died after only 1 year of severe defoliation; the remainder died after 2 years. There was no significant relationship between tree mortality and maturity. Top-kill was most severe on larger diameter trees and immature trees sustained very little top-kill.

Douglas-fir beetle
Dendroctonus pseudotsugae

Widely scattered pockets totalling 400 ha containing mainly mature predisposed Douglas-fir in 38 areas were killed by Douglas-fir beetle in the Cariboo Region and to a lesser extent in the Vancouver, Prince George, and Nelson regions.

Beetle-killed Douglas-fir in the Cariboo Region were scattered in five pockets over 295 ha mostly on Big Bar Mountain west of Clinton. Additionally, beetle-killed Douglas-fir were mapped by the British Columbia Forest Service in numerous pockets totalling 300 ha, mostly north and west of Williams Lake. Small groups of one to three mature beetle-killed trees, most weakened by overmaturity and root disease, occurred in pockets in the Prince George and Vancouver regions. The Douglas-fir beetle is at generally low endemic levels and little change is forecast in 1988.

A Douglas-fir coneworm
Dioryctria pseudotsugella

New shoots of interior Douglas-fir near Williams Lake and in the Thompson River drainage were defoliated by increased numbers of coneworm larvae. Most of the new tips of overmature Douglas-fir were severely defoliated along the north shore of Williams Lake between Asahal and Mission creeks and increased populations very lightly defoliated Douglas-fir on both sides of Highway 20 east of the Fraser River. In the Kamloops Region, increased populations, often in association with high numbers of western spruce budworm, *Choristoneura occidentalis*, contributed to the overall defoliation, particularly in the Thompson River drainages and to a lesser degree in the Okanagan Valley.

Spruce Pests

Spruce beetle
Dendroctonus rufipennis

The area and volume of mature white and Engelmann spruce killed by spruce beetle in British Columbia declined for the fifth consecutive year to 63 infestations over 3000 ha, from 298 over 3800 ha in 1986. Although this insect was active in all six forest regions, all but 80 ha of the recent beetle-killed stands were in higher-elevation stands south of Gold Bridge and west of Princeton in the Kamloops Region. The continuing decline was due to salvage of infested trees, improved sanitation, host depletion, and low temperatures in 1984 and 1985.

The area of recently killed mature spruce in the Kamloops Region increased for the fourth consecutive year to 2900 ha. Most of this increase was in the Anderson Lake and Gold Bridge areas where 11 remote, high-elevation infestations covered 2050 ha, up from 1360 ha in 1986. West of Princeton in the Upper Tulameen River drainage, infestations increased slightly to 875 ha in 22 pockets.

The area and number of recently killed mature spruce in the Prince George Region declined for the sixth consecutive year to endemic levels in scattered pockets over 17 ha, mostly in the McGregor and Bowron river drainages.

Tree mortality declined to endemic levels in the Prince Rupert Region following years of host depletion from beetle attacks and harvesting; however, pockets of 25 spruce in the upper Kispiox River drainage that were attacked in 1986 contain high numbers of broods which pose a threat to adjacent stands when they emerge in 1988. Current attacks are restricted to single trees mostly in the northeastern part of the region and usually those predisposed by disease or windthrow.

Twenty mature spruce, mostly windthrown, in pockets along the Haines Road north of the Alaska border were very lightly strip-attacked. Trees in the area have been predisposed by the effects of road construction since 1983. However, control programs have effectively reduced the potential for continuing tree mortality.

Little change is expected in the status of the beetle in 1988. However, endemic populations in scattered windthrow, right-of-way logs, and butts of standing trees in most regions have the potential to threaten nearby susceptible mature stands.

Spruce aphid
Elatobium abietinum

The aphid population on the Queen Charlotte Islands increased following 2 years of low populations and severely defoliated older needles of Sitka spruce in coastal areas of Graham Island and northern and eastern Moresby Island. About 70% of the old foliage was lost in a 1984 spruce plantation near the north end of Moresby Island. However, in a 1980 plantation at Miller Creek on Graham Island, only 12% of the trees were severely defoliated, 36% were moderately defoliated, and the rest had light defoliation. In a nearby study plot established in 1982, 60% of the mature spruce are now dead after periodic severe defoliation. Very light feeding on small groups of spruce occurred at isolated locations north and south of Prince Rupert. On Vancouver Island and on the lower mainland coast in the Vancouver Region, increased populations moderately defoliated Sitka spruce and severely defoliated ornamental spruce from Port Hardy to Hope.

Overwintering populations are significantly influenced by temperatures and often increase following mild conditions such as those which occurred in 1987.

Spruce weevil
Pissodes strobi

Weevil attacks in 9- to 14-year-old Sitka spruce at seven sites in the Kitimat River Valley in the Prince Rupert Region killed 2 to 63% (average 29%) of the terminals. The highest incidence of mortality was in three stands adjacent to the river where an average of 58% (range 50 to 63%) of the leaders were killed. In the remaining stands,

mortality ranged from 2 to 27%, declining with distance and elevation from the river. Elsewhere in the western part of the region, terminal leader mortality at 10 sites averaged 38% (range 0 to 45%). Leader mortality is very low (average 8%, range 0 to 26%) in five stands in the western part of the Skeena River Valley and 6% (range 2 to 12%) in four stands in the northern part of the Nass River Valley where extensive planting of Sitka spruce is planned.

Spruce bud insects

New growth of young Sitka spruce in the western part of the Prince Rupert Region was damaged for a second year. Spruce budmoths, particularly *Zeiraphera canadensis*, damaged an average of 72% of the new buds of 6- to 14-year-old trees in 13 plantations in the Kitimat, Copper, and Skeena river drainages, similar to 1986. A spruce gall adelgid, *Pineus* sp., and pineleaf chermid, *P. pinifoliae*, lightly infested new shoots on 12 to 56% (average 46%) of the Sitka spruce in 11 plantations, similar to 1986.

Northern spruce engraver beetle
Ips perturbatus

Fewer than 50 upper crowns of mature spruce were killed by 1987 engraver beetle attacks in the eastern part of the Prince George Region. Most were widely scattered throughout the McGregor and Parsnip river drainages; no current damage was seen in the Torpy and Bowron river valleys. The decline from 4000 tops killed in 1985 was due to undetermined causes.

True Fir Pests

Budworms
Choristoneura spp.

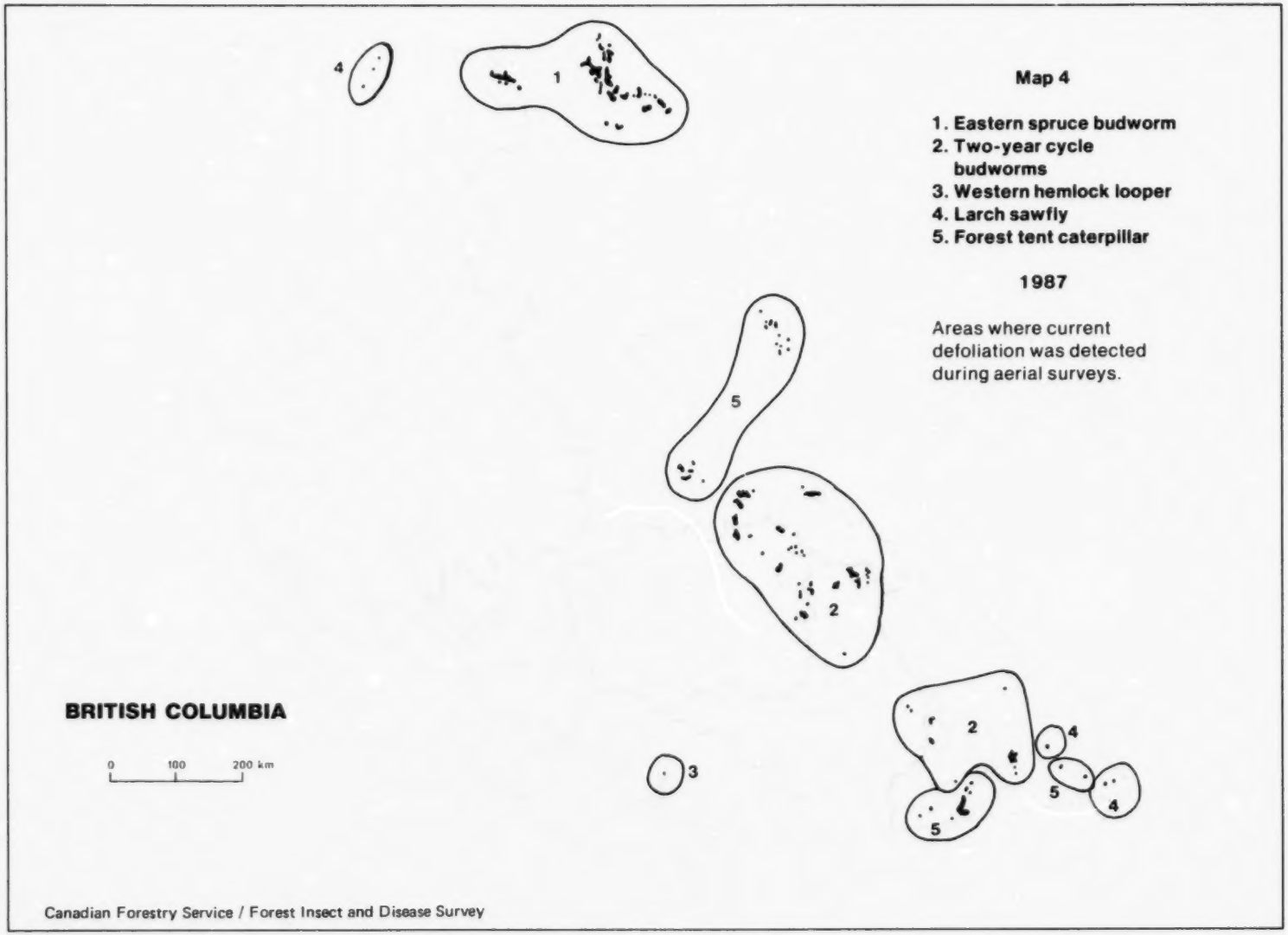
Defoliation of alpine fir and spruce forests in four forest regions by eastern spruce budworm and 2-year cycle budworms was mostly light over 59,400 ha and 59 750 ha, respectively (Map 4).

Defoliation of current foliage of alpine fir and white spruce by eastern spruce budworm, *Choristoneura fumiferana*, was light to moderate over 59 400 ha along the Fort Nelson and Liard river valleys in the Prince George Region and into the Northwest and Yukon territories. Light defoliation occurred for the second consecutive year between Coal and Smith rivers, near Liard Hot Springs and Kledo Creek west of Fort Nelson. The infested area mapped by aerial survey declined from nearly 95 000 ha in 1986, which was the first year of expansion since the mid 1970s. The apparent decrease may have been due, in part, to poor weather which delayed aerial detection surveys by a month and reduced aerially visible evidence of light budworm feeding. Adult male moths were caught in pheromone-baited non-sticky traps near Fort Nelson and Liard Hot Springs. The numbers of male moths (average 43, range 0 to 102) indicate budworm populations will be variable but will continue in the Fort Nelson area in 1988.

Most of the alpine fir-spruce forests defoliated by early-instar, 2-year cycle budworm, *C. biennis*, were in the east and southeastern parts of the Prince George Region. Light defoliation in 36 infestations covered 20 000 ha, up 22% from 1986 and up from 580 ha defoliated by similar early-instar larvae in 1985. Most defoliated stands at Everett Creek, near Tumuch and Stoney lakes by the Cariboo regional border, had been defoliated by mature larvae in 1986. New infestations developed over 4000 ha in the Morkhill River drainage.

In the northeastern part of the adjacent Cariboo Region, mostly around Quesnel Lake, 78 alpine fir-spruce forests over 11 250 ha were lightly defoliated.

Sixty-nine separate infestations in the upper


Map 4
1. Eastern spruce budworm
2. Two-year cycle budworms
3. Western hemlock looper
4. Larch sawfly
5. Forest tent caterpillar
1987
Areas where current defoliation was detected during aerial surveys.
BRITISH COLUMBIA
0 100 200 km
Canadian Forestry Service / Forest Insect and Disease Survey

North Thompson River drainage, including Lempriere Creek, covered 17 000 ha, most of which had been also lightly defoliated by mature larvae in 1986.

Although high numbers were forecast from 1986 egg samples, significant feeding damage was not expected to occur until 1988 when larvae mature. The mild 1986-87 winter and warm 1987 spring probably increased larval survival, bud mining, and defoliation intensity.

The high numbers of eastern budworm and 2-year cycle larvae in defoliated fir-spruce stands in the Prince George, Cariboo, and Kamloops regions indicate continuing populations and potentially widespread defoliation in 1988.

Immature "off-year" 2-year cycle budworm larvae defoliated 60 pockets of high-elevation alpine fir-spruce over 11 500 ha in the Nelson Region, mostly in the East Kootenay. As predicted from 1986 egg samples, defoliation in the upper St. Mary River drainage west of Kimberley, including Dewar, Redding, and Baker creeks, was severe over 475 ha, moderate in 13 separate infestations over 3500 ha, and light over 5000 ha. In Bugaboo Creek west of Invermere, new shoots were lightly defoliated over 700 ha. In the West Kootenay, five areas were lightly defoliated over 1650 ha in Fosthall and Cusson creeks, where infestations first developed in the early 1980s. Along Airy Creek west of Slocan, four pockets of fir-spruce were lightly defoliated for the first time. Based on egg samples in three stands, young larvae are forecast to be numerous in alpine fir and spruce buds in 1988, but are not expected to cause significant defoliation until they mature in 1989.

To improve and calibrate methods to detect budworm in fir-spruce forests, larvae and male adult populations were monitored at 16 locations in three regions. Although up to 200 larvae and 300 males were collected per location, further data are necessary before numbers can be correlated with population changes and damage.

Balsam woolly adelgid
Adelges piceae

For the first time the adelgid was discovered substantially beyond the 1976 regulation and infestation zones (Map 5). Mature amabilis fir were severely infested and about 30% were killed in a 150-ha mixed conifer stand on West Thurlow Island in Johnstone Strait about 80 km north of the zone's boundary. Mortality of amabilis fir had occurred over several years.

Limited aerial surveys and ground checks of an additional 63 amabilis and grand fir stands within and outside the zones on Vancouver Island, the Lower Mainland and along the international border in the Nelson Region found only very light active populations and only within the quarantine zone. These included lightly infested twigs on up to 35% of the amabilis fir in three seed orchards near Victoria and one near Nanaimo. Mortality of mature amabilis fir attributable to adelgid attack averaged 15% (range 0 to 95%) in or near 10 damage plots established by the CFS in 1966 and 1970 near Victoria and Vancouver.

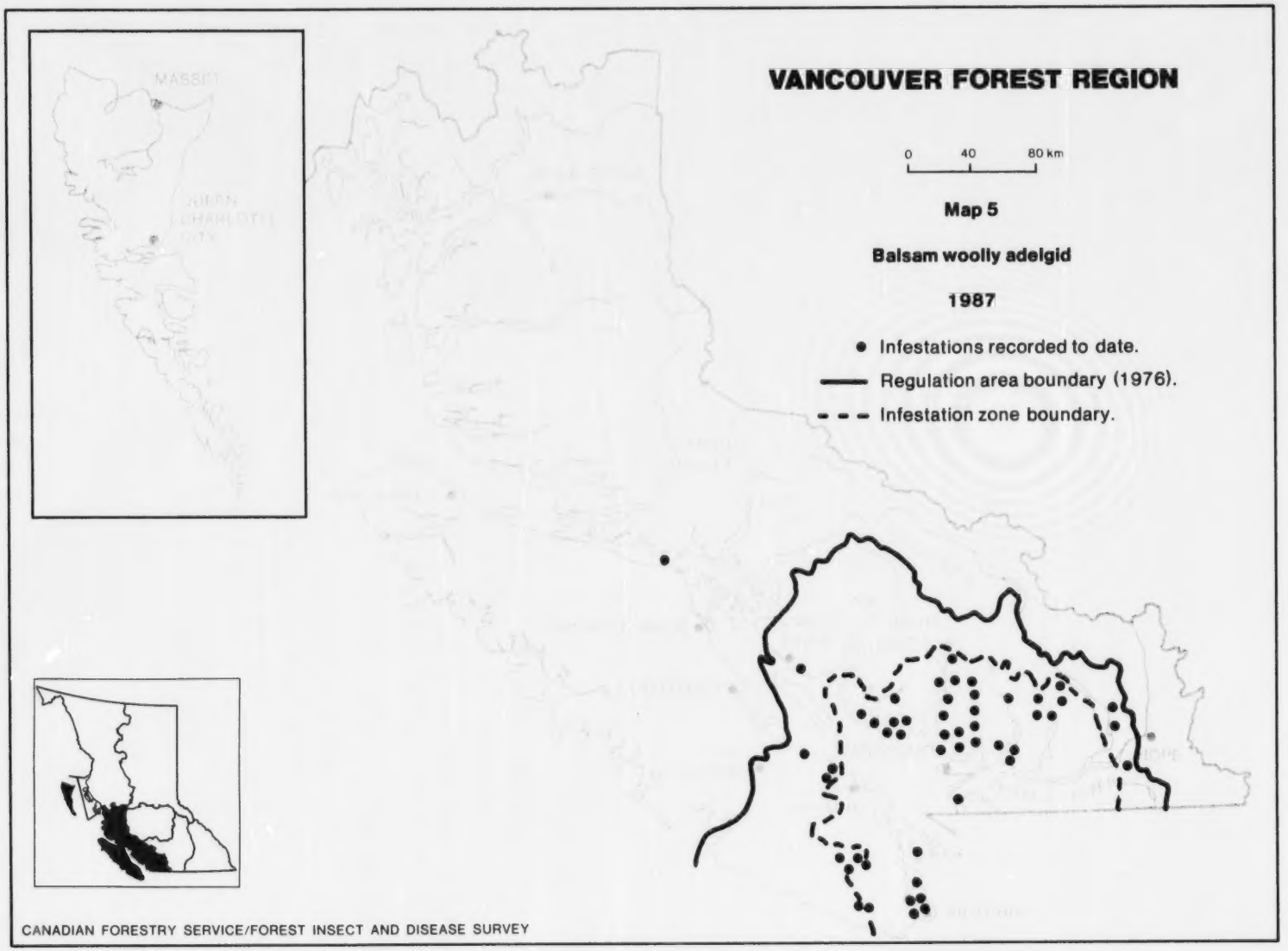
Changes to quarantine and regulation zones are being considered because of the discovery on West Thurlow Island. Detection and monitoring surveys will continue in 1988.

Western balsam bark beetle
Dryocoetes confusus

Mortality of mature high elevation alpine fir was mapped in more than 320 separate infestations over 9150 ha in six forest regions. Additionally, 70 000 ha in the Bulkley TSA in the Prince Rupert Region contained recently killed mature alpine fir.

Most of the fir killed by the beetle-fungus complex in the Prince George Region in 140 infestations covering 6125 ha were in the Morkhill, McGregor, and Monkman river drainages east of Prince George and near the northwest arm of Takla Lake. Lesser damage occurred northwest of Finlay Forks along the Mesilinka River.

In the Cariboo, Kamloops, and Nelson regions, areas containing recent beetle-killed trees mapped by aerial surveys declined to 80 ha, 1750 ha, and 775 ha, respectively, in about 140 separate infestations; in 1986, the corresponding figures were 375 ha, 2250 ha, and 2370 ha in about 200 infestations. Additionally, more than 320 pockets totalling 1600 ha were mapped in the


VANCOUVER FOREST REGION
0 40 80 km
Map 5
Balsam woolly adelgid
1987
Infestations recorded to date.
Regulation area boundary (1976).
Infestation zone boundary.
MASSET
QUEEN CHARLOTTE CITY
CANADIAN FORESTRY SERVICE/FOREST INSECT AND DISEASE SURVEY

eastern part of the Cariboo Region by the British Columbia Forest Service.

In the Vancouver Region, however, infestations expanded slightly to 420 ha in 44 pockets containing an estimated 10 450 trees (11 410 m^3). Most were in the Mowhokam and Kookipi creek drainages; lesser damage occurred near Pemberton and at Alfred Creek on the Sunshine Coast.

Hemlock Pests

Western blackheaded budworm and Hemlock sawfly

Acleris gloverana and *Neodiprion tsugae*

In the third consecutive year of outbreak on the Queen Charlotte Islands, blackheaded budworm and hemlock sawfly larvae defoliated about 220 separate mature and immature western hemlock stands over an estimated 14 100 ha (Map 6), about a third of the area affected last year. Additionally, tree mortality following successive years of severe defoliation was mapped over 1500 ha and in widely scattered pockets totalling 2170 ha throughout defoliated stands. Populations collapsed near Kitimat, near Creston in the Nelson Region, and near McBride in the Prince George Region. New blackheaded budworm infestations developed in hemlock stands in the Kamloops Region over 1100 ha and in a single 5-ha stand near Holberg on Vancouver Island. In the eastern part of the Prince Rupert Region from the Nadine River northwest to near Hazelton most white spruce and alpine fir stands were very lightly defoliated. Budworm populations in the area have been common since 1982, but population levels have fluctuated and little damage has resulted.

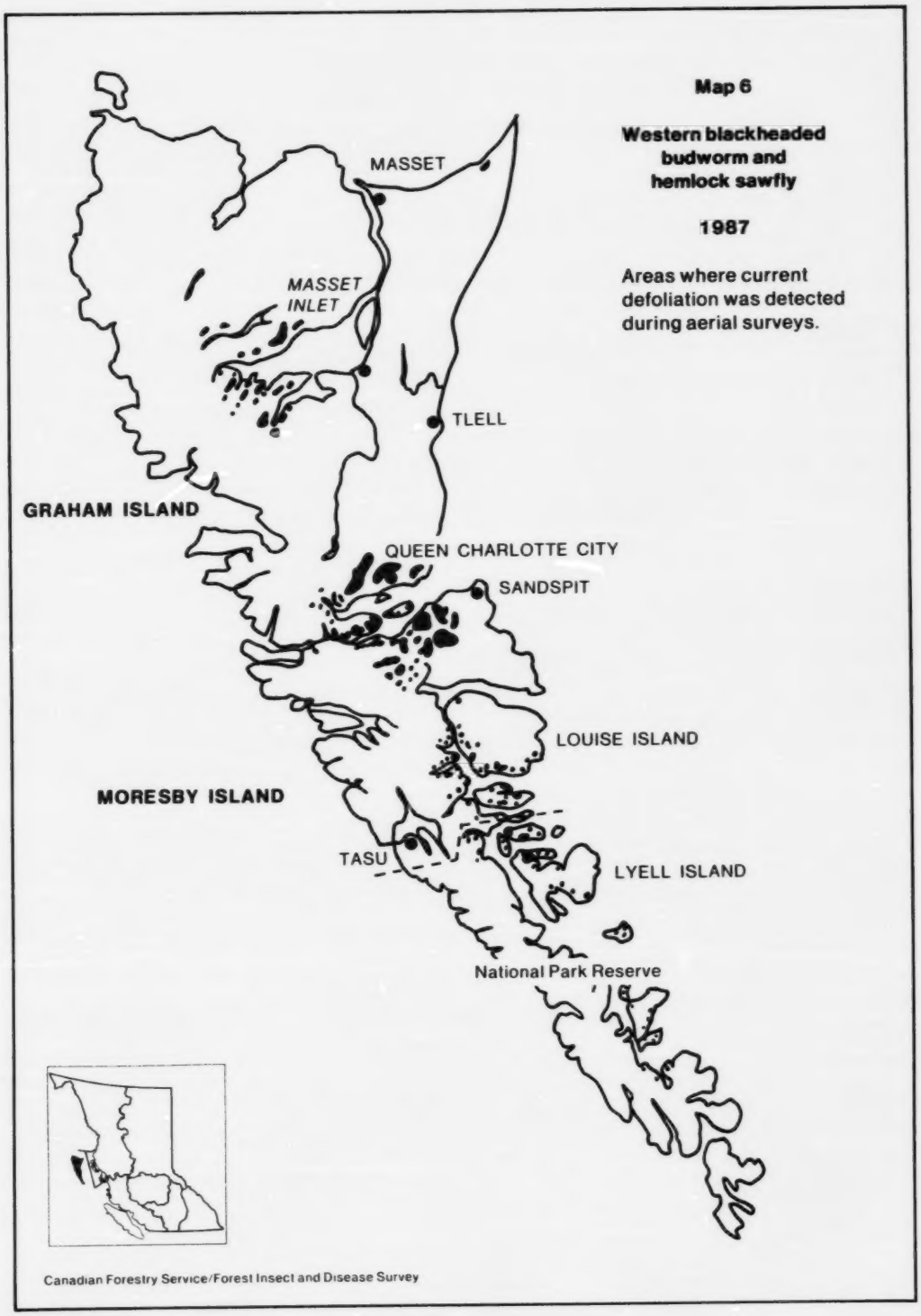
Defoliation, mostly on Graham Island, totalled 14 100 ha of which 19% was severe, 61% was moderate, and 20% was light. In most areas, defoliation was caused primarily by hemlock sawfly feeding on older foliage and budworm defoliating the new foliage. Defoliation of mature western hemlock in mixed hemlock-cedar stands in the Kamloops Region was light in five separate infestations in the upper Clearwater River drainage, in Wells Gray Provincial Park, and in the upper Adams River drainage east of Avola. A single 5-ha pocket of mature hemlock was very lightly defoliated near Holberg. This was the first incidence of defoliation on Vancouver Island since a previous outbreak collapsed in 1973.

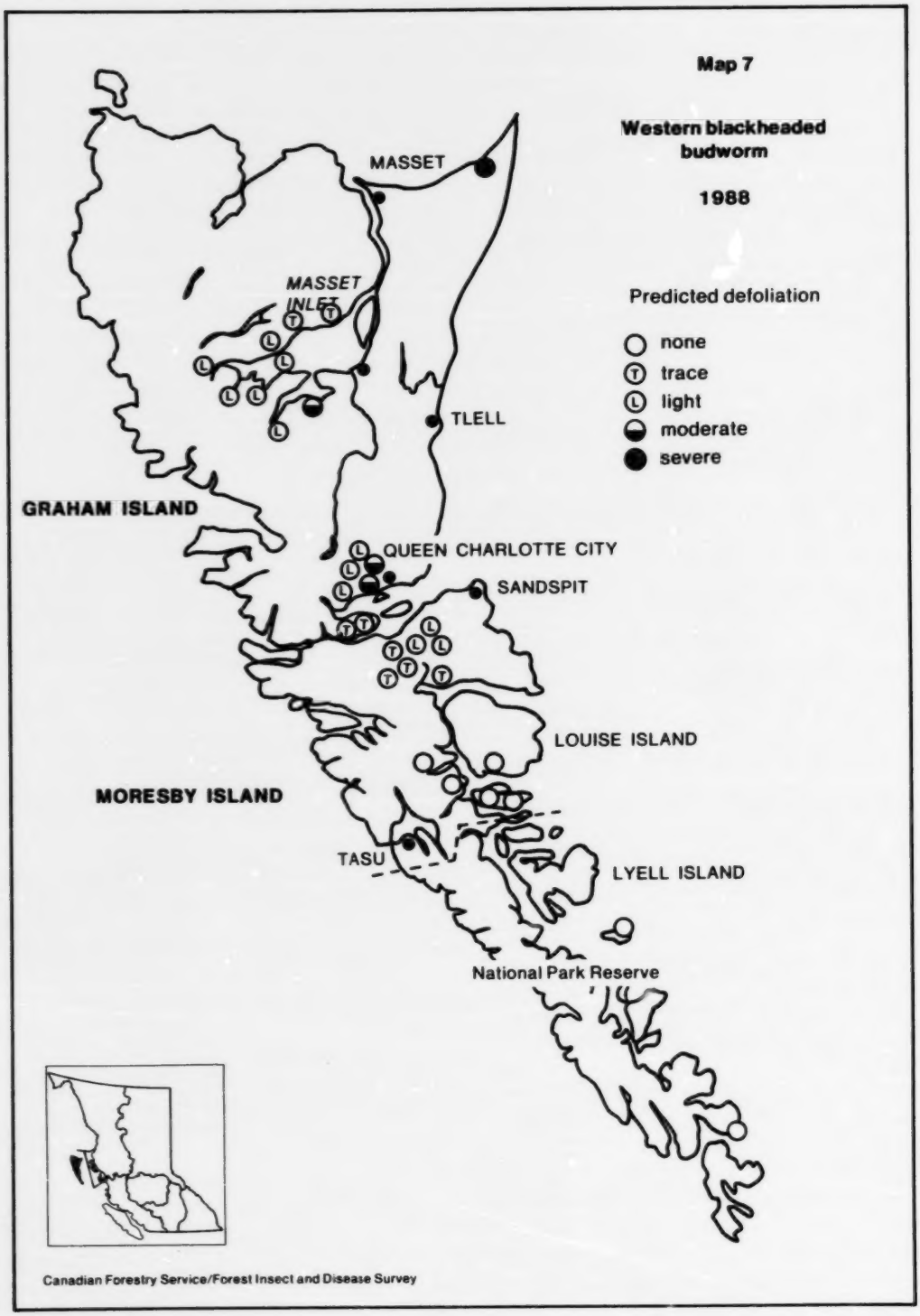
Defoliation of western hemlock stands on the Queen Charlotte Islands is forecast to decrease in 1988; defoliation will be severe at only one location, moderate at three, trace or light at 24, and seven sites will be free of defoliation (Map 7). Assistance in obtaining samples for egg washing from the 35 sites was provided by the British Columbia Forest Service and forest industry personnel. Severe defoliation of western hemlock is forecast near Holberg, and light defoliation is forecast in the inaccessible stands in the northern part of the Kamloops Region. Although defoliation is not forecast near Kitimat, new shoots of white spruce and alpine fir at seven locations in the eastern part of the Prince Rupert Region could be lightly or moderately defoliated.

Parasitism of blackheaded budworm larvae from Honna River on the Queen Charlotte Islands averaged 6%, which is too low to reduce populations, and less than an average of 16% in three areas in 1986.

Numerous hemlock sawfly cocoons on 50-cm hemlock branches at 11 of 26 sites indicate damaging population levels, mostly on Graham Island, in 1988. Mortality of prepupal sawfly averaged 54% (range 10 to 88%) at 26 sample sites. Infection by *Entomophthora* occurred at only one site while viral infection at all sites averaged 14% and parasitism averaged 38%.

Tree mortality estimated during aerial surveys averaged 25% (range 1 to 80%) in 77 separate infestations totalling 3670 ha, mainly on Moresby Island. About half of these were in 20- to 100-


Map 6
Western blackheaded budworm and hemlock sawfly
1987
Areas where current defoliation was detected during aerial surveys.
MASSET
MASSET INLET
TLELL
GRAHAM ISLAND
QUEEN CHARLOTTE CITY
SANDSPIT
LOUISE ISLAND
MORESBY ISLAND
TASU
LYELL ISLAND
National Park Reserve
Canadian Forestry Service/Forest Insect and Disease Survey


Map 7
Western blackheaded budworm
1988
Predicted defoliation
none
trace
light
moderate
severe
MASSET
MASSET INLET
TLELL
GRAHAM ISLAND
QUEEN CHARLOTTE CITY
SANDSPIT
LOUISE ISLAND
MORESBY ISLAND
TASU
LYELL ISLAND
National Park Reserve
Canadian Forestry Service/Forest Insect and Disease Survey

year-old stands; the remainder were in older stands. Evidence in 1987 of refoliation of previously defoliated tops has deferred impact assessments at 10 plots established on the Queen Charlotte Islands in 1985 (two on Moresby Island and eight on east coastal islands) until after the outbreak has collapsed.

Semimature hemlock in plots established in 1975 near Port Alice on Vancouver Island following defoliation by blackheaded budworm in 1972-74 were surveyed this year but showed no evidence externally of growth impact such as dead trees, tops, or branches. Volume loss through reduced increment is being re-evaluated.

Western hemlock looper
Lambdina fiscellaria lugubrosa

A new hemlock looper infestation developed in multi-age western hemlock over about 90 ha on the west side of Jervis Inlet north of Sechelt in the Vancouver Region (Map 4). Western hemlock were severely defoliated and so, to a lesser degree, were western red cedar, broadleaf maple and other deciduous understory shrubs in four patches between Patrick Point and Crabapple Creek on the southwest side of Queens Reach. High numbers of adults in infested stands in September indicate continuing populations in the area in 1988. High numbers of hemlock looper but no defoliation were last recorded in the area in 1969; near Coquitlam Lake stands were defoliated for 5 consecutive years resulting in mortality and harvesting of mature western hemlock.

Larch Pests

Larch casebearer
Coleophora laricella

After 2 successive years of decline, casebearer populations were generally endemic in western larch stands in the Nelson and Kamloops regions. Isolated pockets of moderately defoliated mature larch occurred, however, in previously infested stands in the Nelson Region near Castlegar, Montrose and Fruitvale. Lightly discolored pockets occurred at Thrums, Rossland, and Anarchist Mountain in the West Kootenay and in the East Kootenay between Koocanusa Lake and Creston where populations declined significantly. Defoliation at 16 of 26 long-term study sites between Koocanusa Lake and Anarchist Mountain averaged less than 10% and was restricted largely to the lower third of the crowns. Trees in the remaining plots were not defoliated. Populations in the western part of the host range in the Kamloops Region were at endemic levels and defoliation was not seen from Salmon Arm south to Anarchist Mountain.

Discoloration of western larch by the larch needle diseases *Hypodermella laricis* and *Meria laricis*, combined with casebearer damage, often complicated accurate identifications.

Prepupal parasitism ranged from 3 to 38% (average 18%) at 21 of 25 sample locations and there were no pupae at one site. A native chalcid, *Spilochalcis albifrons*, and an introduced parasite, *Chrysocharis laricinellae*, were most common while *Agathis pumila* occurred only in very low numbers. As part of a biological control program initiated by the Forest Insect and Disease Survey of the CFS in 1966, about 331 of the male and female European parasites *C. laricinellae* and *A. pumila* were released between mid July and August in three casebearer-infested stands near Castlegar.

Defoliation of western larch is forecast to increase slightly to generally light with moderate defoliation near Castlegar and Rossland and patches of severe defoliation east of Vernon. This is based on overwintering larval population assessments at 20 sites in the Nelson and Kamloops regions.

A trapping program to monitor the spread of casebearer populations beyond known distribution limits indicates a slight expansion of adult populations. An average of six adults (range 1 to 10) were caught in five traps at each of four locations.

Larch sawfly

Pristiphora erichsonii

Increased sawfly populations lightly or moderately defoliated western larch in the southeastern part of the Nelson Region and tamarack in the northern part of the Prince Rupert Region west of Watson Lake and in southeastern Yukon (Map 4). Populations declined in exotic larch near Haney in the Vancouver Region.

Populations in western larch between Elko and Sparwood lightly or moderately defoliated 11 pockets of mixed age stands totalling 600 ha; this followed a population decline in the area in 1985. An additional 100 ha were defoliated at Dutch Creek. Defoliation averaged 44% at two locations in the Elk River valley and 45% at Dutch Creek west of Fairmont. Between 41 and 90% (average 64%) of the overwintering sawfly cocoons at the three sites were healthy, indicating continuing populations in 1988. Populations are also expected to continue north of Elko to Bull River where increased numbers of larvae but no visible defoliation occurred in 1987.

Numerous small groups of tamarack in the northern part of the Prince Rupert Region south of the Yukon border, where sawfly larvae have occurred periodically since 1959, were moderately defoliated by increased sawfly populations. Increasing populations but no defoliation of tamarack occurred along the Robert Campbell Highway and Tungsten Road and west of Watson Lake in the Yukon Territory following a decline in 1986.

Several exotic larch in Terrace were severely defoliated by sawfly, the first record of the defoliation in the area; none was found on Siberian, Japanese, and European larch in 25-year-old plantations in the Kalum Valley near Terrace. Sawfly colonies in native and exotic larch plantations in the University of British Columbia Research Forest in Haney collapsed after severely defoliating western larch for 2 consecutive years.

Larch needle diseases

Hypodermella laricis
Meria laricis

Discoloration of western larch by needle diseases was conspicuous for the second consecutive year in the western part of the host range in the Nelson and Kamloops regions, and to a lesser degree in the southeast. The area and intensity of infection varied, but the infection was generally more severe and widespread than in 1986.

Infection by both *Meria laricis* and *Hypodermella laricis* was most evident in the West Kootenay between Westbridge and Beaverdell, where single trees and stands up to 5 ha were moderately to severely discolored. At Johnstone Creek Provincial Park and in the Halfway River Valley about a fifth of the crowns of all the western larch in 20-ha patches were infected and discolored. Lightly infected smaller patches were common north of Kaslo along Kootenay Lake.

Infection increased slightly in the East Kootenay and severely infected larch stands along Koocanusa Lake in the Lussier and White river drainages and near Moyie Lake. Lightly discolored small patches of larch were numerous in the St. Mary River Valley and were also common elsewhere throughout the host range, most noticeably in the Purcell, Gold, and Cabin creek drainages.

In the Kamloops Region, areas of western larch infected by *M. laricis* expanded slightly in the eastern part of the region. Severely infected stands were most common in 1- to 200-ha patches east of Vernon to Cherryville. Scattered pockets lightly infected by *H. laricis* were numerous from Naramata to east of Kelowna and east of Vernon including Silver Star Provincial Park. Pockets of mature larch in mixed conifer stands in the north Okanagan from Glenemma to Falkland were severely infected and discolored and larch in pockets of 1 to 5 ha west of Tappen, near Sicamous, and east of Salmon Arm were moderately infected and discolored.

Larch budmoth

Zeiraphera improbana

Endemic budmoth populations occurred in parts of the Nelson and Kamloops regions where west-

ern larch stands were defoliated from 1983 to 1985.

Very small numbers of larvae but no feeding damage were evident near Castlegar, Johnstone Creek, and Anarchist Mountain in the West Kootenay, but none was found in previously infested stands west of Castlegar or near Yahk in the East Kootenay. Low populations persist in small, higher-elevation pockets of western larch near Vernon and none was evident in other previously infested stands east of the Okanagan Valley.

Multiple Host Pests

Black army cutworm
Actebia fennica

New infestations of black army cutworm severely defoliated conifer seedlings and herbaceous ground cover and delayed planting programs in 2-year-old burns in the East Kootenay and in the Kamloops Region. Significant population declines occurred in previously infested areas of the Prince Rupert, Prince George, and Cariboo regions.

Spruce and pine seedlings, planted in late 1986, and patches of ground cover over an estimated 1000 ha were severely defoliated in parts of the 1985 Ram Fire east of Canal Flats in the Nelson Region. Planting in the nearby Giby Fire was delayed until larval feeding, which severely defoliated patches of ground cover over about 900 ha, was concluded. Small numbers of larvae occurred in the Black Fire in the same general area and at Marl Creek north of Golden. However, neither larvae nor feeding damage was observed during surveys of other recent burns in Matthew and Findlay creeks in the East Kootenay, nor in burned sites in the West Kootenay at Aaron Hill and Wilson Creek.

About 10% of the newly planted Douglas-fir seedlings in a 2-year-old burn in the Fly Hills near Salmon Arm in the Kamloops Region were moderately to severely defoliated by greatly increased cutworm larval populations. Most herbaceous ground cover on ridge tops and west-facing slopes on about 5% of the 80-ha area were totally defoliated. On a 150-ha site at the upper end of Otter Creek near Vavenby which was burned in 1984, larvae destroyed half the foliage on 10% of the Douglas-fir seedlings. Additionally, all ground cover foliage in about six patches over up to 1 ha on west facing slopes and ridge tops was totally stripped and up to 20 late-instar larvae were counted in 1000-cm^2 duff samples.

Cutworm larvae were at their lowest levels in recent years in previously infested areas in the eastern part of the Prince Rupert Region. Fewer than three larvae per 1000-cm^2 duff sample, no seedling damage, and only minimal feeding on ground cover were evident in burned sites at Harold Price and Pinkut creeks, near Smithers Landing and Chapman Lake.

Populations of black army cutworm completely collapsed in the Prince George Region following several years of high populations which severely defoliated newly planted conifer seedlings. Recovery of severely defoliated seedlings in addition to seedling mortality is being assessed. There was no evidence of larval feeding where larvae had been numerous in 1986 including the Bowron River drainage, Haggen Creek, and the Missinka River drainage north of Prince George.

There was little evidence of cutworm larvae in the Cariboo Region, where populations were common but damage was minimal in 1986. Very low numbers of larvae were seen for the first time in a 1986 burn at Victoria Creek east of Quesnel, but there was no feeding damage to the Douglas-fir and white spruce seedlings or to ground cover. Other sites burned in 1986 in the northeastern part of the region including Little River and Mackay River valleys and Bosk Lake

where pheromone-baited sticky traps attracted 10 or more male adults in 1986 showed no signs of larvae this year.

Parasitism of cutworm larvae and pupae, respectively, averaged 22% and 37% in the Prince Rupert, Prince George, and Cariboo regions in 1986. This contributed to the population decline along with predation by voles and birds and virus infection. Larval and pupal parasitism in new infestations in the Nelson Region averaged 2.3%, too low to reduce populations in 1988. However, at Otter Creek near Clearwater in the Kamloops Region parasitism approached 50%.

Continuing populations are forecast for parts of the Nelson and Kamloops regions, but cutworm populations should remain low elsewhere. This is based on 230 sticky and four multipher traps baited with experimental pheromones which attracted up to 64 male moths per trap at 43 sites in four regions. An additional 93 traps (57 sticky, 36 multipher) set out by the British Columbia Forest Service near Clearwater in the Kamloops Region attracted up to 45 adults per trap (average 11). Cutworms could pose a threat to 1988 plantings where slash burning occurred in 1986 in parts of the interior.

Building on earlier work conducted by Dr. Roy Shepherd in cooperation with FIDS, a 3-year contract to develop a predictive warning system linking moth catches in pheromone traps with subsequent defoliation as well as seedling and vegetation damage was started this year.

Rhizina root disease, *Rhizina undulata*, was abundant in several cutblocks north of Hazelton in the Prince Rupert Region. There was no damage on spruce and pine seedlings planted this year. This fire-related disease was first observed affecting conifer seedlings in British Columbia in 1967 and in the Prince Rupert Region in 1968. Damage was usually prevalent in the first year after the burn, slightly reduced in the second year, and had usually disappeared in the third year.

As predicted, populations of the variegated cutworm, *Peridroma saucia*, which occurred for the first time in high numbers in 1986 in the eastern part of the Cariboo Region, were not present on the site in 1987. Some spruce seedlings and ground cover over part of the plantation had been severely defoliated. Overwintering mortality of pupae was 77%; 64% died during the winter, predation killed 11%, and 2% were parasitized. Pheromone-baited sticky traps at two recently burned sites nearby attracted an average of one and five moths, probably too few to sustain a potentially damaging larval population.

Cone, seed, and seed orchard pests

Cone crops were generally light to occasionally heavy in interior forests and rare in coastal areas. Cone and seed pests were at the highest levels in recent years due in part to favorable overwintering conditions. Western spruce budworm, widespread at epidemic levels, also contributed to a high incidence of damage in at least two seed orchards. A Douglas-fir coneworm, *Dioryctria pseudotsugella*, infested most cones throughout the Kamloops Region and parts of the Cariboo and Vancouver regions. Douglas-fir cone moth, *Barbara colfaxiana*, infested up to 85% of the cones (average 28%) at 34 sites in four regions, although most of the damage occurred in the Kamloops Region and the eastern part of the Nelson Region. Spruce cone maggot, *Lasiomma anthracina*, infested up to 80% of white and Engelmann spruce cones at 12 sites mainly in the Prince Rupert, Prince George, and Nelson regions. A spruce seed moth, *Cydia strobilella*, infested up to 70% of the white spruce cones in northern regions and up to 85% of the Engelmann spruce near Creston in the Nelson Region. A pine cone borer, *Eucosma rescissoriana*, infested 30% of the shore pine cones at Mayer Lake Provincial Park on the Queen Charlotte Islands; this was the first record of the insect on the islands.

Ten coastal and two interior seed orchards were surveyed in 1987. For the second consecutive year, Cooley spruce gall adelgid, *Adelges cooleyi*, severely infested Douglas-fir in five coastal seed orchards and up to 25% of the Sitka spruce in four orchards. Balsam woolly adelgid, *Adelges piceae*, lightly infested twigs of up to 35% of the amabilis fir in three orchards near Victoria and another near Nanaimo; all are within the infestation and regulation zones. A previously undescribed gall midge, *Contarinia* sp., galled buds of yellow cedar seed orchard stock at three locations on southern Vancouver Island. Up to 4% of the male and 2% of the female cones at one location were affected. Western red cedar midge, *Mayetio-*

la thujae, damaged up to 40% of the cones in two orchards. Control actions using Dimethoate were implemented in most coastal seed orchards against moderate to high populations of Douglas-fir gall midge, *Contarinia oregonensis*, (90% of cones infested), Douglas-fir conemoth (45%), and fir coneworm (55%). Ground and aerial applications of Sevin and *Bacillus thuringiensis* were made at Skimikin seed orchard against high numbers of western spruce budworm.

Pests of Young Stands

As part of an ongoing province-wide survey, current damage by about 35 active pests was identified on 12 conifer hosts in 62 stands (60% planted, 40% natural; 2 to 25 years old) in five forest regions. Most common was Cooley spruce gall adelgid which lightly infested new growth of three spruce hosts and Douglas-fir in 20 stands. Pine stem and branch rusts were also found. Western gall rust, *Endocronartium harknessii*, infected an average of 11% of the lodgepole pine in 17 stands. *Cronartium* species were on 11% of the lodgepole pine in nine stands in the Prince George Region, and white pine blister rust, *C. ribicola*, killed or infected 21% of the white pine in three stands in the Nelson and Vancouver regions. Warren's root collar weevil, *Hylobius warreni*, killed an average of 4% (range 1 to 6%) of the young lodgepole pine in three plantations in the Prince George Region.

Sclerophoma pithyophila, a dieback disease of Douglas-fir which usually follows drought, frost damage, and other injuries, infected up to 20% of 10- to 12-year-old Douglas-fir in three plantations in the Cariboo Region causing dieback of 35 cm to 1 m. Most of the Douglas-fir in 1982 plantations at Tsekut Lake southwest of Stuart Lake in the Prince George Region and near Whiskers Point on McLeod Lake were poorly formed with multiple tops, dead leaders, and lateral branches; this was attributed to infection by *S. pithyophila*.

Infection by *Atropellis piniphila* in young stands at Opatcho Lake in the Prince George Region was 29% in nonspaced areas but less than 1% in spaced areas. However, western gall rust, *Endocronartium harknessii*, was more common, infecting 40% of the trees in spaced stands and 34% of the trees in nonspaced stands. In natural stands near Tumbler Ridge, British Columbia and Rancheria in the Yukon Territory, the rust infected up to 25% of the regeneration lodgepole pine. Comandra and stalactiform blister rusts infected only 1% of the young lodgepole pine in four stands from Prince George to the Cassiar Highway and four locations in the Yukon Territory from the Hyland River Valley to near Atlin including Takhini Forest Reserve near Whitehorse.

The incidence of leader mortality in immature lodgepole pine stands caused by *Pissodes terminalis* in the western part of the Cariboo Region declined to less than 7% overall from about 16% in 1986. Stands examined were along the Taseko and Palmer lake roads. There was a significant reduction in broods by undetermined causes in stands near Trout Creek in the eastern part of the Prince Rupert Region. Although leaders attacked in 1986 were dead, 70% did not contain broods even though egg-laying niches were evident. At Andrews Bay near Ootsa Lake, 90% of the early-instar larvae were dead in pine terminals attacked in 1986.

Animal damage

Mortality of recently planted conifer seedlings suspected to be caused by high numbers of meadow voles, *Microtus* sp., increased significantly in the eastern part of the Prince Rupert Region. This resulted in adjustments to site preparation plans in some areas. Feeding on seedling stems was more common but less severe in poorly burned and nonburned sites than in burned sites. Buds and branches below patches of bark chewed by voles, particularly in nonburned sites, are expected to survive.

The greatest vole damage was at Crow Creek and Maxan Lake west of Burns Lake where 37% of the 1986 planted lodgepole pine and 16% of the white spruce were killed and another 24% damaged. Seedling mortality at three sites northeast of Telkwa at Covert Creek and near Tanglechain Lake was 30% and 10% in two nonburned sites and 20% in a burned site; seedling damage was 30%, 30% and 16% at the three sites. At Lamprey Creek, 45% of the seedlings planted in 1985 were damaged (38%) or killed (7%), and 30% were damaged at Andrews Bay. In a 1986 burn at Poplar Lake, 35% of the stock planted in 1987

were damaged and 5% were killed by girdling. In an adjacent plowed, nonburned area, 20% of the seedlings were killed and 50% were severely damaged.

Up to 45% of the young pine in 3 of 15 conifer plantations near Ootsa and Maxan lakes were severely girdled near the base, possibly by hares. An additional 50% of the trees were lightly debarked. Most severe damage was to 9-year-old conifers in a 15-ha area near Ootsa lake. Damage at two other sites was severe on up to 16% of 6-year-old trees and light on 20% of 4-year-old trees. Feeding damage was present at the remaining 12 plantations at very low levels.

Patches of bark were chewed by porcupines from the stems and branches of conifers in young and semimature stands in the western part of the Prince Rupert Region. This is expected to result in continuing widespread tree mortality.

Climatic injury

Mortality of terminals of regeneration white spruce attributed in part to late frost has occurred every spring for the past 5 years in the eastern part of the Prince Rupert Region, most noticeably in the Kispiox TSA. Assessments this year indicate 20% of the terminals in young spruce stands at Date and Kuldo creeks have been killed since 1982, of which nearly half (45%) now have multiple leaders. Near Goosly Lake, 12% of the 10-year-old white spruce had developed multiple leaders due to dead terminal buds; an additional 7% on better sites had only single leaders.

East of Meziadin Lake in the Prince Rupert Region about 80% of the planted Sitka spruce had multiple deformities and breakage from previous years' snowfall. Stem deformity, broken branches and forked tops caused by heavy wet snowfall affected most Douglas-fir in a 1974 plantation at Crawford Creek near Creston in the Nelson Region. Similar damage was common in overstocked regeneration lodgepole pine elsewhere in the East Kootenay including Teepee, Weaver, and Kutlits creeks.

Acid rain monitoring

Since 1984, observations for acid rain symptoms or symptoms which mimic those of acid rain have been made in British Columbia at 15 permanent plots and more than 590 permanent sample stations by FIDS rangers as part of the Acid Rain National Early Warning System. Symptoms directly attributable to acid rain, including premature needle discoloration and loss of needles, have not been seen. About 20 tree species and numerous species of ground cover were generally healthy. Damage observed was usually attributable to previous or current pest conditions.

Fume damage

Older needles of mature western hemlock on the east side of Neroutsos Inlet on Vancouver Island discolored by sulphur dioxide emissions from a nearby pulp mill at Port Alice were less evident than in 1986. Interveinal discoloration of alder and salmonberry was very light over about 10 ha about 1 km east of the mill; conifer foliage was not usually affected. New shoots of hemlock over about 240 ha 1 km north of the mill were apparently healthy.

The impact of periodic fume emissions on conifers east of Kimberley is being evaluated on plots established by the Forest Insect and Disease Survey of the CFS in the late 1960s.

Deciduous and Ornamental Tree Pests

Tent caterpillars
Malacosoma spp.

Defoliation of deciduous trees and shrubs by increased populations of forest tent caterpillar, *Malacosoma disstria*, was more severe and widespread in parts of the Cariboo, Kamloops, Nelson, and Prince George regions than in 1986 but declined in the Peace River area (Map 4). Western tent caterpillar, *M. pluviale*, populations in southwestern British Columbia declined due to increased virus infection, which resulted in less severe defoliation of mixed deciduous stands, including alder, than in 1986. Populations in the Okanagan Valley increased for the second consecutive year.

Forest tent caterpillar populations around Prince George increased significantly and defoliated trembling aspen in 70 separate infestations over 8300 ha, up from 580 ha in 1986. Defoliation, mainly west and northwest of Prince George near Chief and Nukko lakes in the Salmon River drainage and east near Tabor Mountain, was light on 26% of the area, moderate on 43%, and severe on the remainder.

Declining populations in the Peace River area caused light and moderate defoliation of about 55 aspen and cottonwood stands over 8650 ha, down from 91 700 ha in 1986. The decline in the fifth year of infestation in some areas was mainly in the Pine River Valley west of Fort St. John and south to Tupper and between the Kiskatinaw River and Groundbirch. Cold wet weather in the area during larval activity may have contributed to the decline.

In the Nelson Region, trembling aspen, cottonwood, and birch in about 120 separate stands over 7250 ha were moderately or severely defoliated by forest tent caterpillar, mostly near Trail, Rossland, Castlegar, and Slocan. This was a sixfold increase from 1986 and the fourth consecutive year of defoliation in some areas. Numerous small pockets of mixed deciduous stands from Creston to Golden were lightly defoliated and several cottonwood stands totalling 200 ha near Kitchener and in the Kootenay River Valley near Fort Steele, Wardner, and Galloway were severely defoliated for the first time in 10 years.

Increased forest tent caterpillar populations in the Kamloops Region severely defoliated poplar, willow, maple, and birch over about 5 ha at the south end of Monte Lake and along Chase Creek south of Falkland. In the North Thompson River Valley, where the last infestation in the region occurred in 1979, willow and maple over 20 ha south of Barriere were severely defoliated.

There was no evidence of populations between Kitwanga and Moricetown in the Prince Rupert Region where populations collapsed in 1986 following 2 successive years of high numbers and defoliation of aspen over 900 ha.

Egg mass samples from five recently infested stands in the Prince George Region including the Peace River area indicate continuing populations and variable intensities of defoliation in 1988. Defoliation is also forecast to continue in the Nelson Region in the West Kootenay between Rossland and Slocan, and in the Kootenay River Valley near Fort Steele.

Western tent caterpillar colonies in southwestern British Columbia were numerous and widespread, in some areas for the seventh consecutive year. In most areas, however, up to 50% of the larvae were infected and killed by nuclear polyhedrosis virus before they matured. This resulted in significantly less defoliation throughout the Fraser Valley, the Sunshine Coast, the Gulf Islands, and in east coastal areas on Vancouver Island than was expected considering the high numbers of young larvae and numerous colonies earlier in the year.

Alder and white birch over about 100 ha near Hagensborg and near Belarko in the Bella Coola area of the Vancouver Region were lightly to severely defoliated by western tent caterpillar. This is the first record of this defoliator in the mid-coastal area of British Columbia.

Colonies of western tent caterpillar were also more common and widespread in the Okanagan Valley than in 1986. Defoliation of small pockets of alder, birch, and other deciduous trees and shrubs ranged from light to moderate in the north Okanagan and from Vernon east to Lumby and south to Kelowna. Near Penticton, mixed deciduous stands covering up to 10 ha were lightly to moderately defoliated.

Newly developing infestations in the Bella Coola and Okanagan valleys are expected to continue in 1988, but virus-infected populations in southwestern British Columbia should decline further.

Gypsy moth
Lymantria dispar

About 8244 pheromone-baited sticky traps were monitored throughout British Columbia in the thirteenth year of the cooperative program with Agriculture Canada (Plant Health), the British Columbia Forest Service, and the Forest Insect and Disease Survey of the CFS.

In total, 221 adult male gypsy moths were captured in 56 traps in six areas compared with 24 moths in 19 traps in 1986. Males were caught for the second consecutive year at Kelowna (194, up from 7 in 1986) and near Canadian Forces Base Esquimalt (5, up from 3 in 1986). New catches were made at Qualicum Beach (1) and Parksville on Vancouver Island (12), and near Tsawwassen south of Vancouver (3). New egg masses were found at Kelowna (30), Belmont Park (7), and Parksville (3), where 29 old egg masses were also found.

No adults were found in 282 traps set by the Forest Insect and Disease Survey of the CFS in 233 forested recreation areas in national and provincial parks, commercial campgrounds, near military bases, and north coastal ports.

Intensified monitoring and periodic control programs have prevented establishment of gypsy moth populations in British Columbia and defoliation has not been observed. Following 3 years of positive trapping and four applications of *Bacillus thuringiensis* in 1987, no adults were captured at Chilliwack. Potential quarantine restrictions and costly control programs remain the major concerns of the forestry sector should populations become established.

Male adult trapping, and, when necessary, egg mass surveys will continue in 1988 in cooperation with Agriculture Canada (Plant Health) and the British Columbia Ministry of Forests and Lands.

Satin moth
Leucoma salicis

Black cottonwood in a small stand at Stump Lake south of Kamloops was severely defoliated. Elsewhere in the Kamloops Region, populations which had defoliated small areas of trembling aspen during the previous 2 years were at endemic levels.

Western winter moth
Erannis tiliaria vancouverensis

Mixed deciduous stands in the North Thompson River Valley in the Kamloops Region were defoliated for the second consecutive year. In adjacent parts of the Cariboo Region stands were defoliated for the first time in 10 years. Patches of mixed-age birch, maple, and poplar of up to 50 ha between Barriere and Clearwater were moderately to severely defoliated, particularly west of Little Fort at Eakin Creek where stands were defoliated for the first time in 1986. White birch along the south shore of Mahood Lake in the eastern part of the Cariboo Region was lightly to moderately defoliated for the first time. Scattered pockets of maple and willow in the Vancouver Region were lightly or severely defoliated by increased populations near Boston Bar, in the Skagit River Valley, and in Golden Ears Provincial Park near Haney. Previous infestations, the last in 1972 near Pemberton, declined after 2 years.

Infestations of 2 to 3 years in duration have occurred periodically since 1949 in coastal and interior deciduous forests. Currently high populations in the interior are expected to remain so in 1988, particularly in the Clearwater area in the Kamloops Region. High larval populations in 1987 followed very high numbers of adults in the area in late 1986.

Winter moth
Operophtera brumata

Winter moth, *Operophtera brumata*, populations on southern Vancouver Island were at very low levels for the third consecutive year. Defoliation of deciduous trees and shrubs, mainly Garry oak and maple, was very light and scattered in Greater Victoria, the Saanich Peninsula, and the western communities. Defoliation was not evident at Duncan, Nanaimo, and Saltspring Island.

Parasitism by the introduced parasitic fly *Cyzenis albicans* and the wasp *Agrypon flaveolatum* released periodically since 1979 and considered as the major cause of the winter moth decline, was about 60% overall in an initial evaluation. This was up from an average of 44%, mainly attributed to *C. albicans*, in 1984 and 1985.

Poplar leaf and shoot blight
Venturia macularis

Increased infections resulted in significantly more widespread and severe discoloration of trembling aspen than in recent years in the Cariboo Region and lesser damage in parts of the Nelson and Prince George regions. Infections declined in the Prince Rupert Region. Groups of moderately infected trees over 1 to 10 ha were common from Clinton to 100 Mile House, from Lac La Hache to Quesnel, and from Horsefly Lake to Riske Creek and west to Hagensborg. In the Nelson Region, increased infection severely discolored scattered groves of trembling aspen near Wasa and between Fairmont and Invermere. Infection in regeneration aspen increased over 1986 levels on several hectares along the Fort Liard Highway where up to 10% of the crowns of most trees were infected. Infection declined between Kitwanga and Cedarvale in the Prince Rupert Region for the second consecutive year; only trace infection in scattered pockets was found.

A birch leaf skeletonizer
Lyonetia saliciella

Discoloration of scattered patches of white birch was widespread in the northern part of East Kootenay in the Nelson Region, in some areas for the thirteenth consecutive year. High populations severely defoliated 16 stands over more than 2000 ha from Forster Creek near Invermere north to Golden. Birch stands north of Golden were only lightly defoliated.

Poplar-and-willow borer
Cryptorhynchus lapathi

Willow mortality caused by the poplar-and-willow borer was more common and widespread than in 1986, affecting up to 70% of the branches on numerous willows in the eastern part of the Cariboo Region and in the Prince George area. Recovery of the borer from the Prince George and McBride areas represents a significant expansion of its known range.

New Records of Occurrence and Distribution

Insect or Disease	Host	Remarks and Location
	Conifer hosts	
Balsam shoot borer, *Argyresthia* sp.	Grand fir	First collection from western *Abies* spp.
Blight on seedlings, *Rosellinia minor*	Engelmann spruce	New record in British Columbia on seedlings at Maple Ridge
Blight on shoots, *Sirococcus strobilinus*	Mountain hemlock	New host record on regeneration near Port Clements
Blight on shoots, *Sydowia polyspora*	Balsam fir	New distribution record in the Yukon killed frost damaged terminals
Canker fungus, *Nitschkia molnarii*	Whitebark pine	New host record from Smithers
Cypress bark moth, *Cydia cupressana*	Eastern white cedar	New record of this in British Columbia from Kelowna and Victoria
Dieback fungus, *Ascocalyx* sp.	Douglas-fir	New host record from McLeod Lake
	Western larch	New host record near Houston
Dieback fungus on leaders, *Cladosporium* sp.	Siberian larch	New host record at Fort Nelson
Dieback fungus on branches, *Kabatina juniperi*	Rocky Mountain juniper	New host record at Savona
Dieback fungus, *Phacidium gaeumannii*	Engelmann spruce	New host record in British Columbia from Horsefly
	Norway spruce	New host record at Fort Nelson
	Douglas-fir	New host record at Hope and Vavenby
	Western larch	New host record at Grand Forks
	Western hemlock	New host record at Nakusp
Dieback fungus, *Phoma* sp.	Siberian larch	New host record at Fort St. James
Dieback fungus, *Sclerophoma semenospora*	Ponderosa pine	New host record at Rock Creek
Dieback fungus, *Sclerophoma* sp.	Siberian larch	New host record at Fort St. James
Dieback fungus, *Tympanis laricina*	Western white pine	New host record at Nanaimo

Insect or Disease	Host	Remarks and Location
Eastern spruce gall adelgid, *Adelges abietis*	Sitka spruce	First collection of European species in British Columbia at Victoria
Epiphyte (leaf), *Epipoleaum* sp.	Western yew	New host record at Tofino
Epiphyte (bark), *Karschia* sp.	Whitebark pine	New record in British Columbia from Smithers
Epiphyte (bark), *Stigmina* sp.	Western hemlock	New host record at Courtenay
Epiphyte, *Verrucaria plumbaria*	Deodar cedar	New host record at Victoria
Fletcher scale, *Parthenolecanium fletcheri*	Eastern white cedar	New host record in British Columbia at Penticton and Kelowna
Fly speck fungus, *Leptopeltis* sp.	Yellow cedar	New record in British Columbia at Sooke and Slocan Park
Gall midge, *Contarinia* n. sp.	Yellow cedar	New record in British Columbia at four sites on Vancouver Island, two in the Fraser Valley and near Prince Rupert
Hyperparasite on dwarf mistletoe, *Cladosporium* sp.	Lodgepole pine	New host record on dwarf mistletoe seeds at Parson
Hyperparasite on dwarf mistletoe, *Glomerella cingulata*	Western larch	New host record at Christina Lake and Grand Forks
Hyperparasitic fungus, *Aegerita fungicola*	Western hemlock	New host record at Parksville
Larch sawfly, *Pristiphora erichsonii*	Larch sp.	New distribution record on exotic larch at Terrace
Needle blight, *Sphaeropezia* sp.	White spruce	New record for British Columbia at Mackenzie
Pale spruce gall adelgid, *Adelges strobilobius*	Black spruce	First record in British Columbia at Fort St. John - galls
Pine needle scale, *Chionaspis pinifoliae*	Grand fir	New host record for British Columbia at Sidney
Resin midge, *Cecidomyia* n. sp.	White spruce	New species collected on container stock at Duncan, Skimikin, and Red Rock

Insect or Disease	Host	Remarks and Location
Resin fungus, *Claussenomyces olivaceus*	Grand fir	New host record at Sechelt
Rust, *Gymnosporangium nelsonii*	Creeping juniper	New record for the Yukon south of Jakes Corner
Saprophytic fungus, *Pithya vulgaris*	Atlas cedar	New host record associated with *Sirococcus strobilinus* on stressed trees in North Vancouver
Spruce bud scale, *Physokermes piceae*	Grand fir	New host record at Sidney
Spruce gall adelgid, *Adelges lariciatus*	Black spruce	First record in British Columbia at Fort Nelson - in galls
Western gall rust, *Endocronartium harknessii*	Jeffrey pine	New host record for British Columbia at Victoria
Wood decay fungus, *Pholiota squarrosa*	White spruce	New host record at Hazelton
---------- Deciduous hosts ----------		
Birch leafminer, *Fenusa pusilla*	Birch	New distribution records at Smithers, Castlegar, Penticton, and Prince George. This is the first record of this European species beyond Fraser Valley.
Birch leafminer, *Profenusa thomsoni*	White birch	New distribution records at Nelson, Kamloops, Blue River, and Sicamous. This insect was previously recorded at Prince George in 1985.
Canker on stem and branch, *Nectria cinnabarina*	Siberian elm	New host record for British Columbia at Merritt
	European mountain ash	New record for the Yukon at Takhini Forest Reserve near Whitehorse
Dieback (branch) *Tympanis* sp.	Trembling aspen	New host record for the Yukon at Teslin
Dieback (twig) *Godronia multispora*	White birch	New record for British Columbia at Revelstoke
Gall fungus, *Gloeosporium* sp.	Oak	New host record for British Columbia at Victoria

Insect or Disease	Host	Remarks and Location
Gall midge, *Dasineura gleditchiae*	Honey locust	First record for western Canada at Victoria, Kelowna, and Nelson
Leaf blight, *Phyllosticta* sp.	Horse-chestnut	New host record at Harrison Lake
Leaf blight, *Microstroma juglandis*	Walnut	New host record for British Columbia at North Pender Island
Leaf blight, *Taphrina* sp.	Plum	New host record for British Columbia at Saanichton
Leafminer, *Leucoptera laburnella*	Laburnum	New distribution record at Campbell River
Leaf spot, *Septoria aceris*	Vine maple	New host record for British Columbia at North Vancouver
Leaf spot, *Septoria alnifolia*	Sitka alder	New record for British Columbia. This pest is common in the Slocan Valley and along Highway 23 to Revelstoke.
Leaf spot, *Mycosphaerella* sp.	European mountain ash	New host records for the Yukon at Takhini Forest Reserve near Whitehorse
Leaf spot, *Stigmina* sp.	Trembling aspen	New host record for British Columbia and the Yukon at Cassiar and Dawson City
Mycorrhizal mushroom, *Tricholoma populinum*	Soil and duff	New record at Victoria
Root rot, *Phytophthora cactorum*	Arbutus	New host record for British Columbia at Victoria
Rust, *Gymnosporangium nidus-avis*	Sitka mountain ash	New host record for British Columbia near Bear Lake in the Prince George Region
Saprophyte on bark, *Stemphylium* sp.	Willow	New host record for British Columbia at Grand Forks